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This initiative is to demonstrate the feasibility of using expert system technology to assist TRADOC combat developers with the assignment of equipment readiness codes. These codes identify the essentiality of individual equipments to the performance of the overall unit mission. The objective of the system is to facilitate the consistent application of policy and practice in the assignment of the codes and thereby contribute to the management of unit logistic readiness. The approach is to: (1) focus on a selected number of company-size types and codify the present assignment policies and practices into rule sets; (2) develop a prototype expert system based on the rule sets, using a commercially available expert system development tool; and (3) conduct a concept evaluation of the prototype system at a field location (TRADOC HQ).

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STUDY REPORT
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EXPERT SYSTEM INITIATIVE IN LOGISTIC READINESS (EXSYN)

MARCH 1987

PREPARED BY
FORCE SYSTEMS DIRECTORATE

US ARMY CONCEPTS ANALYSIS AGENCY
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CONCEPTS ANALYSIS AGENCY

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DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF:

CSCA-FSL (5-5d)

27 AUG 1987

MEMORANDUM FOR: Deputy Chief of Staff for Operations and Plans (DAMO-ODR), Washington D.C. 20310-0544

SUBJECT: Expert System Initiative in Logistic Readiness

1. The Deputy Chief of Staff for Operations and Plans requested the U.S. Army Concepts Analysis Agency (CAA) evaluate the feasibility of using expert systems technology to assist TRADOC combat development personnel with the assignment of equipment readiness codes (ERC) to items of equipment within units. The ERC identify the relative importance of the equipment to the performance of the unit mission.

2. This final report presents the results of the feasibility study. Available technology, in the form of expert system development tools, was examined. A prototype expert system of 81 ERC assignment rules was developed using one of these tools, and was satisfactorily demonstrated to combat development personnel at TRADOC HQ. The prototype will provide the basis for development of a full scale system suitable for field use.

3. Your comments and critique of the study are included as Appendix N of the study report.

4. I wish to express my appreciation to the staff elements, TRADOC HQ, and the TRADOC schools which have contributed to the study. Questions and/or inquiries should be directed to the Chief, Logistics Systems Analysis Division, Force Systems Directorate, U.S. Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797, AUTOVON 295-1686.

E. B. VANDIVER III
Director

CAA — CONCEPTS ANALYSIS AGENCY — UNITED STATES ARMY	**EXPERT SYSTEM INITIATIVE IN LOGISTIC READINESS (EXSYN)**	**STUDY SUMMARY CAA-SR-87-1**

THE REASON FOR PERFORMING THE STUDY is to examine a possible means for improving the manner in which equipment readiness codes (ERC) are assigned to the equipment in Army units, during documentation of the unit table of organization and equipment (TOE).

THE PRINCIPAL FINDINGS of the work are:

(1) The feasibility of using expert systems technology to assists in the assignment of ERC was demonstrated with a prototype expert system of 81 rules.

(2) Such a system, to be useful and effective, must be further developed with significant involvement by the service schools and the TOE review activities.

THE MAIN ASSUMPTION is that a commercially available, microcomputer-based, expert system development tool was appropriate and adequate for the development process.

THE PRINCIPAL LIMITATION of the study is the restriction of the domain of expertise of the system to a representative sample of units, rather than all the unit types encountered in the TOE development process.

THE SCOPE OF THE STUDY was a representative slice of unit types present in the Heavy Division.

THE STUDY OBJECTIVE was to develop a prototype expert system which demonstrates the feasibility of an expert system to assist combat developers with the assignment of ERC.

THE BASIC APPROACH included:

(1) Selection of an expert system development tool.

(2) Collection, organization, and analysis of information about the manner in which ERC are presently coded.

(3) Coding of this information into an expert system.

(4) Evaluation of the system to establish the extent to which it effectively assigns ERC.

THE STUDY SPONSOR was the Deputy Chief of Staff for Operations and Plans, Headquarters, Department of the Army, who established the objectives and monitored study activities.

THE STUDY EFFORT was directed by Mr. James J. Connelly, Force Systems Directorate.

COMMENTS AND QUESTIONS may be directed to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FS, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

Tear-out copies of this synopsis are at back cover.

CONTENTS

FIGURES

TABLES

EXPERT SYSTEM INITIATIVE IN LOGISTIC READINESS

(EXSYN)

EXECUTIVE SUMMARY

1. PROBLEM. Logistic readiness requires that a unit have the equipment and resources necessary to carry out its mission. The variety of equipment in a unit makes it critical to distinguish between those equipments which make an essential contribution to the unit mission and those equipments which make only a supplementary or supportive contribution. The applicable regulation (AR 220-1) does not provide sufficient guidance to allow the necessary differentiation to be made, on a uniform and consistent basis, by the service school and headquarters activities assigning and reviewing these classifications, in the form of equipment readiness codes (ERC).

2. BACKGROUND. There is a need, therefore, to bring increased systemization to the classification process and, considering the volume and diversity of equipment involved, implement such a system on an automated basis. It may be possible to meet these needs for systemization and automation using the emerging technology of expert systems. These systems provide expert advice by drawing upon a knowledge base containing an extensive set of rules dealing with factors which influence a selection, such as the selection of an ERC.

Given the newness of this technology, it is proposed to conduct an exploration of the feasibility of the expert system approach to the ERC classification problem. It is anticipated that this exploration will result in a prototype expert system which can then be expanded in capability to support the general classification problem in assigning ERC.

3. OBJECTIVE. The objective of the study is to develop a prototype expert system which demonstrates the feasibility of an expert system to assist combat developers in the assignment of ERC during the documentation of the unit table of organization and equipment (TOE). A subsequent effort would develop the production version of the system.

4. SCOPE AND LIMITATIONS

a. For the purposes of the feasibility exploration, the domain (scope) of the prototype expert system will be a representative sector of expertise within the combat developments community and within this sector, a specific set of units (TOE). The specific TOEs to be used by the study will be company-size units within the heavy division, including headquarters elements.

b. The prototype development is a limited effort to establish the feasibility of the expert system approach. It may not fully identify and incorporate all the relevant issues of ERC assignment in the TOE examined, or capture equipment classification issues significant in TOE not examined. However, the inherent flexibility of the expert system technology to accommodate knowledge update would allow for such changes to be incorporated in a subsequent production version of the system.

5. TIMEFRAME. Current (1987).

6. ASSUMPTION. A commercially available, microcomputer based, expert system development tool will be appropriate and adequate to the development process.

7. STUDY APPROACH AND METHODOLOGY. The study involved four distinct areas of work, namely:

- Expert System Tool Selection - Selection of a microcomputer-based, expert system development tool, with which to construct the system from those available (early 1986) on the commercial market.

- Knowledge Base Development - The collection and organization of information about the manner in which ERC are currently coded.

- Knowledge Representation - The coding of this information into an expert system.

- System Evaluation - The evaluation of the system to establish the extent to which the ERC assigned by the system agrees with acceptable coding resulting from current practice.

The principal activities in each area and the relationships among the areas is shown in Figure 1. The principal interaction between the areas is shown by the dashed line recursively connecting the activity of "Codify expertise" with the activity of "Develop equipment classification schema." The process of codifying the expertise is not a simple reduction of the knowledge into a coded counterpart, but a fit of the knowledge into an overall knowledge arrangement or schema. The fitting process is not rigid, however, but adaptive. The knowledge is adapted to the schema, and the schema is broadened and adjusted to account for all the situations found in the knowledge base. As the experience with the coding situations increases, the necessity to adjust the schema decreases and, in the long term, the schema becomes essentially complete.

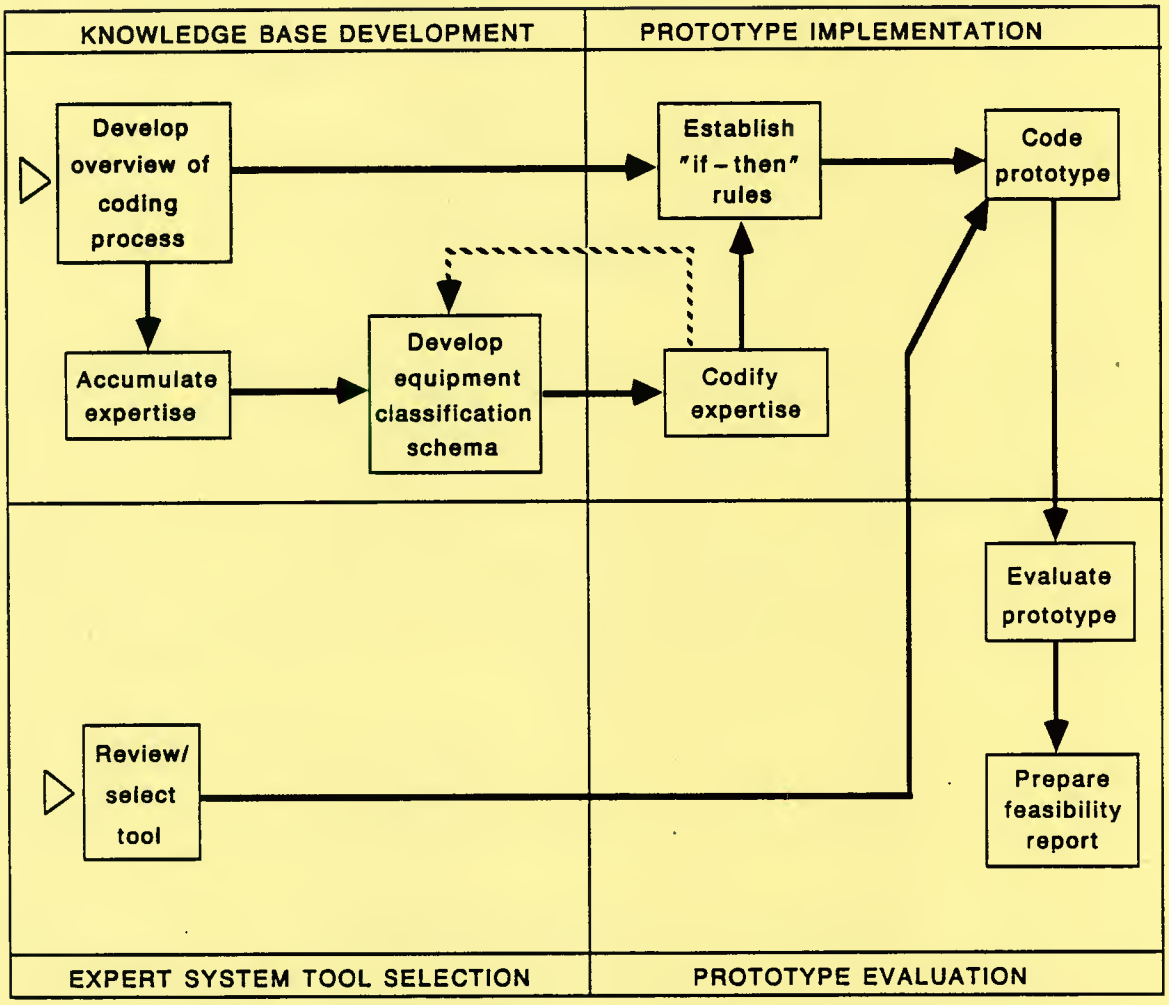

Figure 1. Study Areas and Activities

8. SUMMARY OF FINDINGS AND OBSERVATIONS. Key findings and observations noted in the report include:

a. The feasibility of using an expert system to assist in the assignment of ERC was demonstrated with a prototype system of 81 rules.

b. The system operated satisfactorily on a microcomputer. However, the machine which is currently the standard US Army Training and Doctrine Command (TRADOC) workstation has insufficient memory (256K) to support the system features which store and print out the coding results (audit trail). A workstation with larger memory is needed.

c. The evaluation of the system was more complex than anticipated due to unexpected user responses in operating the system. There is a need for a more formal approach to system evaluation using an experimental design with controls for user training, test conditions and system query language.

d. There must be a tight integration of development and evaluation of the system. The preferred approach would be to proceed with the system development in phases. Each phase would focus on a particular cluster of unit types showing similar equipment support situations. Development and evaluation would be completed for each cluster before moving to the next.

e. The information needed to continue the development beyond the prototype stage requires access to knowledgeable TRADOC individuals in a controlled setting. Workshop settings, located away from (demands of) their work places, appear to offer the best opportunity to interact with these individuals.

f. Such a system, to be effective, must be carefully introduced into the TRADOC working environment. It must be seen as a useful resource, not as an imposed burden. This can best be accomplished by a significant TRADOC involvement in the design for the production system and fielding process. TRADOC personnel must be identified and tasked early in the development of the full-scale production system as the maintainers and managers of the system. The development process itself must be used to provide the hands-on experience and generate the confidence in the production system necessary to carry the system successfully through its initial operating period.

CHAPTER 1

INTRODUCTION

1-1. CHAPTER SUMMARY. This chapter describes the logistic readiness problem arising from the assignment of equipment readiness codes (ERC). It summarizes the current practice in the assignment of the codes, and presents the opportunity to address the problem in a new and more effective way, by using the emerging technology to expert systems.

1-2. PROBLEM

a. Logistics Readiness. As defined in Army Regulation (AR) 11-14, logistics readiness is the state of preparedness of a unit to carry out its mission with respect to the availability of materiel and resources. Equipment readiness codes (ERC) play an important role, as described below in determining the readiness of a unit.

b. Problem Origin. The origin of the problem lies in AR 220-1, Unit Status Reporting, which prescribes the assignment of ERC. The intent of the regulation is to identify, for each item of equipment in an Army unit, the essentiality of that item to the performance of the mission of the unit. A simple, three-level, alphabetic code is assigned (Table 1-1) which ranks the item on a descending scale of essentiality, i.e., essential, supplemental or supportive of the mission. The regulation includes definitions, guidelines, and designations of codes for specific equipment. In spite of this detail, codes are misassigned, with consequences for the readiness of the force as discussed below. The problem is most acute in distinguishing among the essential and supplemental equipment, i.e., ERC-A and ERC-B. The question is, at what point does equipment contributing to the operation of a major item of equipment, transition from ERC-A to ERC-B status? This remains a judgmental issue, and varied interpretations have led to varied assignments.

Table 1-1. ERC Definition

ERC level	Definition
ERC-A[a]	Equipment essential to accomplishing unit mission
ERC-B	Equipment supplemental of the unit mission
ERC-C	Equipment supportive to unit mission

[a]A subset of the ERC-A equipment is coded ERC-P to identify equipment especially critical to mission.

(1) The problem is complicated by the consideration of situations where an equipment contributes to the operation of several equipments, as well as situations where the amount of time an equipment spends contributing to essential operations is a factor.

(2) There is also an institutional consideration. The codes are assigned by the individual TRADOC service schools which have varying missions, doctrinal considerations and equipment types. This variety leads to varying perceptions as to the role and the contribution to the mission associated with various items of equipment.

(3) With the wide variety of equipments present in Army units, and the varied perceptions of the manner in which equipment can be used, simple lists are not adequate, a more sophisticated approach is needed.

c. **Problem Consequences.** The problem with ERC code assignments has consequences in two distinct but related areas.

(1) **Operational Consequence.** Units in the field must report readiness on a monthly basis. Under the status reporting regulation (AR 220-1), all equipment designated ERC-A (i.e., equipment most essential to the unit) must be accounted for by indicating the quantity onhand and ready to immediately perform the mission of the unit. The readiness is measured as the percentage of the ERC-A equipment available and ready, as measured against the required quantity in the unit TOE. It must meet or exceed 90 percent for a C-1 readiness status (highest readiness), meet or exceed 80 percent for a C-2 status, and meet or exceed 65 percent for a C-3 readiness status (units are not fielded below this level). For unit items of equipment in short supply, or deadlined for maintenance, the ERC-A status of an item of equipment may make the difference between a satisfactory and unsatisfactory unit status report.

(2) **Equipment Distribution Consequence.** The shortages of equipment in the field, in part, originate with the allocation of equipment to units. This allocation is carried out semiannually by the Total Army Equipment Distribution Program (TAEDP) and affects Army units worldwide. The computer program considers both the priority of the unit, as reflected in the Department of the Army Master Priority List (DAMPL) and the ERC of the items of equipment in the unit in making the allocation. Inappropriate ERC assignments can cause units with higher priority to receive more equipment than necessary and, for scarce assets, units with lower priority to be shorted.

1-3. CURRENT PRACTICE IN ERC ASSIGNMENT

a. Service School Activity

(1) The ERC are assigned by the TRADOC service schools as a part of the TOE documentation process. The codes are assigned, based on the judgment of the individual combat developer documenting the individual TOE. This judgment is guided by the regulation applicable to the

codes, cited earlier, namely AR 220-1, Appendix B. The judgmental factor is significant in that the appendix does not define all the possible coding cases. The appendix provides:

- Definitions for the three code levels involved (ERC-A, ERC-B, ERC-C).
- Guidance, by means of illustration, for several cases of equipment utilization.
- Designation of specific ERC in an extensive table of coding examples organized by equipment categories.

(2) In spite of this detail, not all equipment types are covered, and in cases where an equipment supports several activities, the guidance provided is "variable coding." In addition to these omissions, there are also situations where understandings have developed at the school level, which result in specific codes being assigned for specific equipment usages which may not be directly relatable to the guidance.

(3) As a control on the ERC assignment process, TRADOC headquarters requires that a school, along with the submittal of the completed TOE, certify that the ERC assignments conform to the regulation.

b. Review Activity. Current practice also includes review of the completed TOE document, including the ERC assignments, by a headquarters review activity. This process can challenge the code assignments made by the school. This raises the question of asserting and defending the rationale for the particular assignment. It is at this point in the ERC process, that perceptions and practices come into play. Objective discussion may be limited by the lack of common understanding of the manner or degree to which a particular equipment relates to the mission of the unit. This lack of a common basis for discussion reflects the lack of a completely definitive regulation.

1-4. EXPERT SYSTEM TECHNOLOGY

a. Concept. Historically, expert systems were developed to capture the knowledge of a particularly well-informed person, so that others could have access to the knowledge in that person's absence. The challenge in developing such a system was to establish a way of capturing the information in a manner compatible with machine (computer) technology. The problem was solved by reducing the knowledge to a set of rules. A rule consists of two sets of statements, paired so that "if" the first set of statements in the rule is true, "then" the second set of statements is also considered true. Using this "if-then" approach, a set of individual rules are established, each containing small insights into the larger problem. When used collectively, the rules lead to useful solutions to the problem.

b. Applications

(1) Expert systems are basically used in decision support situations which have the following characteristics.

- Limited set of choices selected on a judgmental, rather than algorithmic, basis
- Extended set of factors for choice selection
- Need for repeated, if not ongoing, decision activity

Expert system technology can deal effectively with such decision situations. It provides the decisionmaker with an automated tool incorporating all the appropriate knowledge about the decision situation and the means (a search process) for guiding the user to an appropriate choice. Considering this role of providing assistance to a decisionmaker, it is more appropriate to refer to such a system as an ADVISOR (what it does) rather than an EXPERT SYSTEM (where it came from).

(2) It can be observed that the decision situation faced in the assignment of ERC meets the criteria for such as system, namely:

- There is a limited set of outcomes, namely selection of ERC-A, ERC-P, ERC-B, or ERC-C.
- A diversity of considerations are present in the choice, namely all the possible combinations of equipment types and their uses within units.
- The decision is faced a number of times for each TOE, (but not necessarily for each equipment in the TOE), depending upon the experience level of the decisionmaker.

c. Benefits. The expert system, is a well-documented collection of rules. It provides several benefits of institutional value, in addition to support of the individual decisionmaker, as follows.

(1) Visibility. The system as a collection of rules can inherently "explain" its choice by citing the rule(s) involved in the choice. This is a potent benefit, in that the rationale for the choice is, in a sense, public information, not a private thought process. This is not to say that it is intrinsically correct, but that the rule(s) involved provide an objective basis for discussion and review for the selection.

(2) Consistency. The system is readily distributable and, as such, can be used throughout the TRADOC school community to produce consistent coding results.

(3) Continuity. During periods of personnel transition, the system can provide a fixed reference for assignment expertise, by providing both entry-level and experienced new personnel with authoritative coding guidance.

1-5. PROTOTYPE DEVELOPMENT. The study is based on the presumption that expert system technology is appropriate to the application at hand, namely the assignment of ERC. As a first step toward realization of the system, this presumption must be strengthened with evidence that the application is, in fact, feasible. To this end, an initial effort is needed to examine, in detail, the various issues involved before making a final commitment to proceed. The initial effort is in the form of development of a prototype system. The prototype must represent enough of the technology and the application to support a decision to proceed with a full-scale development. The present study is directed toward the development of this prototype. It involves four distinct areas of work, namely:

(1) Expert System Tool Selection. Selection of a commercial, microcomputer-based, expert system development tool.

(2) Knowledge Base Development. Collection and organization of the information about the manner in which ERC are currently coded.

(3) Knowledge Representation. Coding of the collected information into an expert system.

(4) System Evaluation. Evaluation of the system to establish the extent to which the ERC assigned by the system agrees with coding resulting from current practice. These activities are described in the following chapters.

CHAPTER 2

EXPERT SYSTEM TOOL SELECTION

2-1. CHAPTER SUMMARY. This chapter describes the considerations and activity involved in the selection of the expert system development tool used to construct the prototype system. The principal issues in the tool selection were:

- Identification of expert system tools available.
- Establishment of tool selection criteria.
- Tool selection based on criteria.

The following discussion is tailored to the study assumption that a microcomputer-based system will be adequate. More powerful expert systems than those discussed here are available for use on mini- and mainframe machines. The concept, however, was to provide a system for use on TRADOC microcomputer workstations in a stand-alone mode.

2-2. TERMINOLOGY. The following terms, associated with expert systems technology, are provided for reference:

- Expert system - a computer program that uses knowledge and inference procedures to solve problems that normally require human expertise for their solution. The knowledge of an expert system consists of facts and heuristics. The "facts" constitute a body of information which is widely shared, publicly available, and generally agreed upon by the experts in a field. The "heuristics" are mostly private, little discussed rules of good judgment that characterize expert-level decisionmaking in the field.
- Knowledge base - the specific collection of knowledge (facts and heuristics) structured as a set of rules, within an expert system.
- Domain - the nature and extent of the subject matter captured in the knowledge base, that is, the area of expertise of the system.
- Inference - the process by which an expert system works through the set of rules in its knowledge base to a conclusion, using information accumulated during the process to select the next rule to be evaluated.

2-3. TOOL AVAILABILITY. The discussion of the variety of expert systems available is presented by Harmon and King (Ref 6) and Waterman (Ref 7). The authors categorize systems and describe the characteristics of problems appropriate for implementation as expert systems. They do not, however, offer sufficient guidance to make a specific selection. Other considerations are discussed in the following paragraphs.

a. A recent survey (Ref 4) of expert system development queried system developers on the development tools they used. There was a spectrum of response as follows:

- In-house development of the entire system (42 percent)
- Use of commercially available tools (23 percent)
- Mixed use of in-house and commercial products (35 percent)

b. One vendor has mounted an ambitious effort to market artificial intelligence (AI) and AI-based products. In the process, the vendor has evolved a line of expert system products, of increasing capability and cost, advertised as upwardly compatible.

c. Within the US Army, the Signal School at Fort Gordon has advocated a product developed by Teknowledge, called M.1. The Logistics Center at Fort Lee has used the Knowledge Engineering Environment (KEE), a sophisticated tool using a special symbol processing minicomputer.

d. In all, there are 30+ expert system tools currently available (early 1986). Additional entrants continue to come to market. Table 2-1 provides a sample of the tools available, including the list price and the estimated number of systems reported sold, as of January 1986 (Ref 5). The table is organized to group the tools by what is considered their most significant characteristics, namely the mode of operation of the tool. Three modes of operation are employed in the tools: rule-based, example-based and multiple paradigm. The tools employing the multiple paradigm provide not only for rule-building, but also have features which allow symbolic code (LISP) to be integrated into the system. Such systems also have extensive debugging utilities and graphics. These systems, however, are presently limited to operation on minicomputer configurations and were not considered further. The remaining tools are generally microcomputer-based and vary primarily in the manner in which the knowledge is introduced into the system. In the rule-based tools, rules are literally introduced into the system, either in English-like syntax or in a special rule entry language. In the example-based tools, cases of situations are entered and the user is then prompted for factors which discriminate among the situations.

e. The thrust of this discussion is that a variety of tools are available. The status of the technology, however, is such that no clear philosophy of implementation has emerged. The choice of a tool is very much up to the system developer, taking into account the task at hand, the computational resources at hand, and the level of familiarity with the technology.

Table 2-1. Examples of Commercial Expert System Tools[a]

Tool	Cost	Estimated units sold
Multiple paradigm tools		
KEE	$60,000	600
ART	$60,000+	300
Rule-based tools		
EXSYS	$395	1,000+
INSIGHT 2+	$485	300
Personal Consultant	$950	1,200
GURU	$3,000	--
KES II	$4,000	65
M.1	$5,000	408
Example-based tools		
EXPERT EASE	$695	--
RULE MASTER	$1,000	60
TIMM	$5,000	30

[a]Expert System Strategies Newsletter (Jan 86).

2-4. TOOL SELECTION CRITERIA. Based on the information provided in the literature and vendors' information for various systems, a list of pertinent criteria for tool selection was prepared, as shown in Table 2-2, along with a brief statement of the development considerations which influence the selection. The criteria represent the minimum set of concerns appropriate to the application at hand, the experience level in using the technology and the basic technology choices available, as discussed in the following paragraphs.

Table 2-2. Expert System Tool Selection Criteria

Criterion	Development consideration
Application-driven	
PC compatible	System is to be used at TRADOC HQ and school sites which have available PC compatible machines.
Explanation	Explanation refers to the capability of the system to identify why a particular item, requested as input by the system, is needed.
Experience-level driven	
English-like rule syntax	Rules are coded into the system using essentially English sentences. Some systems use a special LISP-like code for rule input and require auxiliary text to be input which is displayed by the system when the user requests an explanation.
Integrated rules editor	An integrated editor is specially designed to create and introduce rules into the system knowledge base. Typically, such an editor can check for the consistent use of rule terminology, identify potential rule conflicts, and rule redundancy. Some systems use an offline text editor, which precludes such checking capability.
Technology-driven	
Rule-based	Rule-based systems, as distinct from example based systems, offer more flexibility in rule formulation.
Backward chaining	Backward chaining for goal selection is the most prominent feature in the systems examined. It is the procedure of choice where a limited number of goals are present.

a. Application-driven Criterion. The microcomputer compatibility issue was invoked to satisfy the desire to have a system which would operate in the present to near-term TRADOC headquarters and school environments. The equipments available are first generation microcomputers with the prospect for some level of upgrade. The explanation facility places emphasis on the need for the system to not only assist with ERC assignment, but to be a source of information on why the particular assignment was made. The explanation capability is inherent in all expert systems, but the needs of this application made it important to explicitly include it as a criterion.

b. Experience-level Driven Criterion. The English-like rule syntax criteria allows the most rapid advance into the application by minimizing the investment to be made in new programing skills. Some limitation in the flexibility of the system design can be anticipated, but is not presently recognizable. The integrated rules editor, to the extent that it can check for the consistency of rule syntax and overall consistency of the rule structure, expedites the development task by reducing the attention needed to the program logic.

c. Technology-driven criterion. The rule-based criteria was based upon the concept that the rules for the system should be based on functionally derived relationships and not on a series of discrimination factors as used in the example-based approach to rule generation. Additionally, the information available suggested that the example-based approach would involve use of scores or scaling factors to act as tie-breakers among completing rules in some choice situations, and this would compromise the integrity of the choice. The backward chaining inference procedure is the more efficient search process when only a few choices are present in the system. Additionally, the backward search process tends to generate queries to the user which are perceived as more logical (more related to one another) than the forward chaining process.

2-5. TOOL SELECTED. The selection of the expert system tool for use on the study was based on a consideration of the criteria identified above, supported by available sales literature, review articles in computer publications, and the opportunity to gain experience with the systems firsthand using demonstration diskettes made available by the system tool vendors. In general, it was difficult to judge the merits of a particular tool from the sales literature or the computer publication reviews. The sales literature tended to be very general, with little description of system characteristics. The review articles were written by general software reviewers, with little or no expert system background experience. The reviewers typically indicated that the systems worked successfully on the toy problems they constructed, but that the choice was ultimately dependent on the user's needs.

a. The choice was finally based upon hands-on experience with two tools, for which demonstration disks were available. While both tools met the criteria, they differed in the way in which they implemented one particular criterion, namely the requirement for English-like syntax in rule formulation. One of the tools represents rules using a LISP-like rule entry language. A separate English text is also input

and this text is used to convey the meaning of the rule to system users. The other tool uses clear English declarative sentences in rule construction.

b. The tool selected for use on the study was the EXSYS tool from EXSYS, Inc. The tool incorporates the features described in Table 2-2. The preference went to this tool for its integrated editor and the use of English-like syntax for rule entry and display to the user. Use of this tool required no experience with LISP or related symbolic programing languages. However, the rule formulation process, while carried out in English, did require the developer to rigorously structure rule statements and understand the effect of backward chaining on the rule order in the knowledge base. In effect, the choice of EXSYS allowed the project to move out almost immediately without a delay to achieve familiarity and facility with rule entry language or symbolic programing.

2-6. DESCRIPTION OF SELECTED SYSTEM. The EXSYS expert system selected for use in the study is a "rule-based" expert system. That is, it is organized into a "knowledge base" containing the equipment coding rules and an "inference engine" which operates to select and apply the rules. This organization is illustrated in Figure 2-1. In addition, there is a "user interface" which provides for user interaction with the system and a "working memory" which holds information on the status of the rule processing.

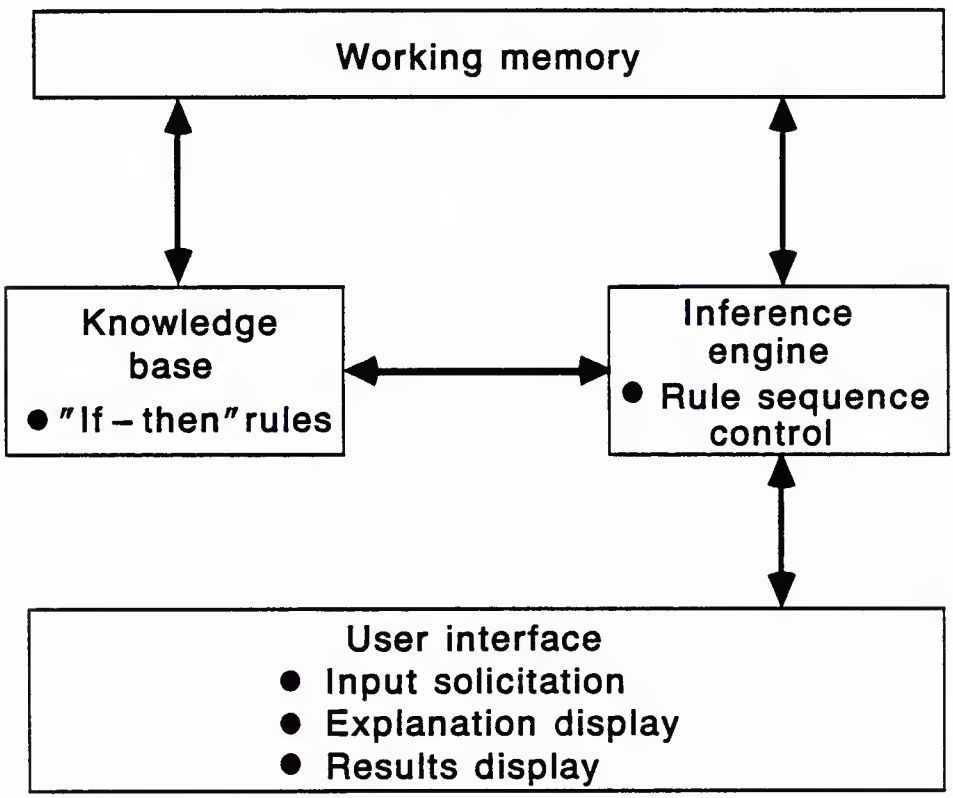

Figure 2-1. Organization of Expert System

a. Knowledge Base. The knowledge base of a rule-based system, shown in Figure 2-1, is an area of computer storage into which the rules are loaded. The organization of the rules is provided by the system developer and is reflected in the sequence in which the rules are "loaded". The sequence may be varied to improve the efficiency with which the rules are searched by the inference engine, but otherwise has no significance in the system operation. The rule organization also allows the developer to maintain an overview of the consistency and completeness of the rules. Lacking this consistency and completeness, the system will fail catastrophically when an unanticipated condition is encountered during rule processing. It is in this sense that expert systems are said to be "brittle" structures.

b. Inference Engine. The inference engine, as shown in Figure 2-1, is the computer term given to the logical processing carried out by the system which allows it to work through the rules in the knowledge base. Unlike traditional programing, there is no strict sequential flow to the processing. Rather, a goal for the system is established (e.g., find an ERC). A search process is then used to determine what is currently known about achieving the goal and what further information is needed. The search process used is referred to as backward chaining or backtracking. A path is traced from the goal back through the rules to establish what must be known in order for the goal to be satisfied. As the backward path is traced, the system asks for input from the user, and the user's responses guide the selection of the next rule considered appropriate. Each item of equipment is processed by a path appropriate to its purposes in the unit as determined by the user's responses to the system's queries. This path-following activity is transparent to the user. All that is apparent to the user is a series of questions, culminating either in a goal selection (ERC assignment), or in an indication that no goal selection (no ERC assignment) is possible, based on the inputs provided.

c. User Interface. The user interface, as shown in Figure 2-1, supports three operations as follows.

(1) Input Solicitation. As the inference engine backward chains through the rules in the knowledge base to satisfy a particular goal, it reaches a point where no additional rule can provide the needed information. It then requests the user for an input corresponding to the first unknown item in the rule and follows this with additional requests for other unknown items, each rule forming part of the logic of the goal selection. For the selected system, the request for input is in the form of a multiple choice. One or more of the presented choices may be selected by the system user as a response.

(2) Explanation Display. At any point where the system poses a question, the user may ask why the input is needed by entering the command "WHY." In response, the system will display the rule being processed. The rule will show how the input requested is embedded with other information in the rule. If other rules are also associated within the request, these will be shown in order until all rules so associated are displayed. When the explanations cease, the system

returns to the point in the assessment where it had left off before the explanation request. Additionally, the system can identify all of the information accumulated up to the present point in the rule processing.

(3) Results Display. The output of the expert system is the selection of a goal from among the alternatives designed into the system.

d. Working Memory. The working memory maintains track of the backward chain of rules for the goal(s) under evaluation. The working memory also accumulates the information input by the user, and the information concluded by the system as rules are found to be true. It references the working memory to answer the user's queries about why inputs are needed and queries about the current state of knowledge about a particular goal selection.

CHAPTER 3

KNOWLEDGE BASE DEVELOPMENT

3-1. CHAPTER SUMMARY. This chapter describes the activity and results associated with the collection and organization of information related to readiness coding by TOE developers and the reduction of this information into rules which are the knowledge base of the system. The principal issues in the knowledge base development were:

- Assessment of the environment within which readiness coding is carried out
- Assessment of coding guidance
- Assessment of coding practice
- Construction of the knowledge base
- Knowledge base status

3-2. ASSESSMENT OF CODING ENVIRONMENT

a. A series of visits was made to the TRADOC schools to collect information on the assignment of equipment readiness codes (ERC). The schools shown in Table 3-1 were visited. During each visit, the participants attended a meeting where the purposes of the study was presented, the information of interest identified and clarified, and examples of coding anomalies discussed. Following the presentation, one-on-one sessions were held with individual TOE developers for a detailed review of selected TOEs. The TOEs were used as a source of examples of equipment coding conditions and variations.

b. The TOE documentation process (of which the equipment readiness code assignment is a small part) is an effort largely involving coordination of existing documentation, rather than an independent analytical effort to establish requirements. In this context, the expert system is an additional reference to be consulted in the coordination process.

Table 3-1. TRADOC Schools Visited

Date	Location	School	Participants
16 Apr 86	Ft Belvoir, VA	Engineer	4
18 Apr 86	APG, MD	Ordnance	4
30 Apr 86	Ft Eustis, VA	Transportation & Aviation Logistics	4 4
1 May 86	Ft Lee, VA	Quartermaster	1
6 May 86	Ft Bliss, TX	Air Defense	6
8 May 86	Ft Sill, OK	Field Artillery	7
20 May 86	Ft Knox, KY	Armor	3
22 May 86	Ft Benning, GA	Infantry	3

3-3. ASSESSMENT OF CODING GUIDANCE

a. Coding Guidance. The guidance for equipment readiness coding is contained in AR 220-1, Appendix C. This appendix (reproduced herein in Appendix D) contains the definitions of the three coding levels to be used and examples of this coding as applied to specific items and categories of equipment. Not all items of equipment are accounted for, particularly lesser items of equipment. More significantly, the information is largely provided in list form. The manner in which the definitions apply in unlisted cases or cases where "variable coding" applies is not addressed.

b. Pacing Item Guidance. In addition to the guidance provided in Appendix C, AR 220-1 includes an Appendix D, which defines pacing items of equipment (reproduced herein in Appendix E). Given that ERC-A equipment are essential to a unit; within the ERC-A equipment there is a subset of equipment designated as the most critical of the essential equipment, namely the pacing, or ERC-P, items of equipment. In addition to the definition of pacing items, AR 220-1 lists examples of specific pacing items in various types of Army units. While AR 220-1 refers to the pacing items listed as examples, current TRADOC policy tends to take the list as being both definitive and exhaustive.

c. BOIP Assignment of ERC. Of particular interest is the interrelationship between the basis of issue plan (BOIP) process and the TOE documentation process. The BOIP documents the equipment needed to support a major item of equipment and is prepared independently of specific TOE. The BOIP is a reference in the TOE development process when readiness coding is considered. In the BOIP, each item of support equipment is assigned a single ERC, which applies to all unit types identified in the BOIP to receive the equipment. This single ERC assignment can be read out of the BOIP by a TOE developer and rotely assigned to the equipment in the unit without further consideration of

its validity. Depending upon the equipment and its use in the unit, this may lead to an erroneous ERC assignment for the equipment in the unit.

3-4. ASSESSMENT OF CODING PRACTICE. The TOE personnel at the schools had varying perspectives on the readiness coding process and the coding situations considered to be of particular importance. These perspectives were not discussed as such, but were either expressed or implied in the way specific coding situations were described. Three perspectives emerged during the course of field visits as follows.

a. Community Perspective. There is a basic conflict between the logistic and operational community perspective on essentiality. The logistic perspective asks whether everything required is there, the operational perspective asks whether the job can be done with what is available. The ERC, while used in both the logistic and operational context, is biased toward the operational (i.e., requirements) perspective.

b. Situational Perspective. Two views were offered on the practice of assessing the impact of the unavailability of equipment in a unit. One position was that many systems can be operated using manual backup arrangements. The other position was that the pace of the conflict will not allow time for *ad hoc* procedures and therefore all the allocated types of equipment are important in getting the job done.

c. Individual Need Perspective. This perspective holds that equipment involving troop support and unit survival, and thereby the effectiveness of the unit, should be considered essential. This puts items such as those for food service, water supply, weapons used for protection, masks, and detectors of various types into possibly higher readiness categories than presently provided.

d. Comments on Coding. Comments by individual school personnel fell into three categories. Some statements were of a general character, some dealt with specific equipment types, and still others dealt with the coding consequences of linkages among equipments. The individual comments, grouped into these categories, are shown in Appendix F.

3-5. KNOWLEDGE BASE ORGANIZATION

a. Equipment Classification Schema

(1) The initial step in the construction of the knowledge base was the development of a system of organization for the rules, referred to as the Unit Equipment Classification Schema. The schema is important for both practical and conceptual reasons. At the practical level, it allows a large number of individual rules to be grouped for design control purposes. At the conceptual level, the schema is a high order statement of the problem solution. It identifies the basic issues and sets the stage for consideration of subordinate issues.

(2) Currently, there are no Army defined support relationships suitable for making the support distinctions necessary for ERC assignment. The Unit Equipment Classification Schema, as shown in Figure 3-1, is structured to provide these support distinctions. The schema is organized to identify the manner in which the individual equipments support the mission of the unit. The definitions of each of the types of equipment included in the schema is shown in Table 3-2.

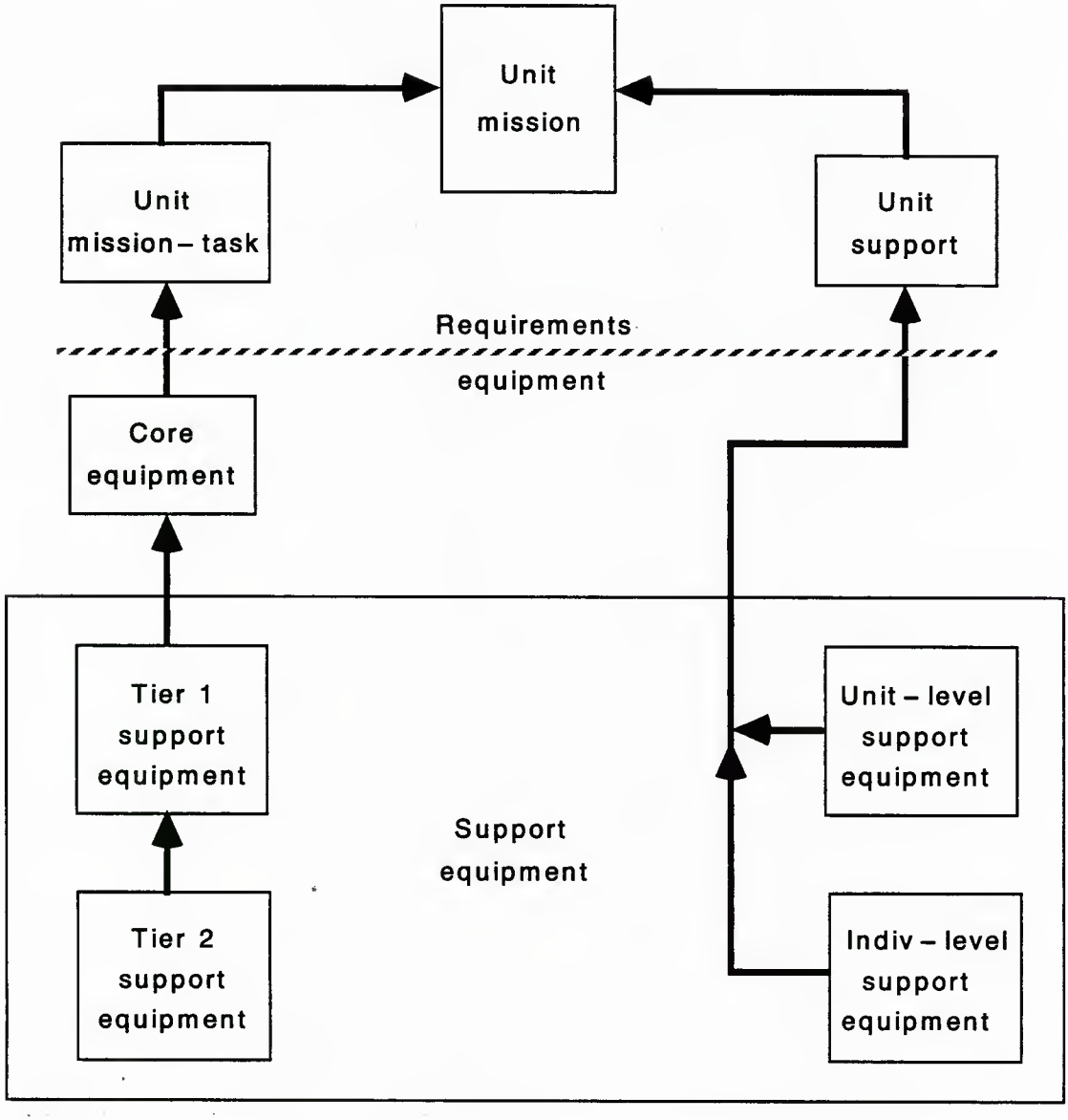

Figure 3-1. Unit Equipment Classification Schema

Table 3-2. Equipment Type Definitions

Equipment type	Definition
Core	Equipment essential to the performance of the unit mission
Tier 1	An equipment which directly supports the operation of a core equipment
Tier 2	An equipment which directly supports the operation of a Tier 1 equipment
Unit-level support	Equipment used to support unit operations and facilities
Individual-level support	Support equipment used personally by individuals to assist them with the performance of their duties

b. Tier (1 and 2) Modes of Support. As shown in Figure 3-1:

- Tier 1 equipment supports the core equipment
- Tier 2 equipment supports the Tier 1 equipment

(1) The support is provided in a variety of ways. Current Army practice (Ref 3) is to identify categories of support for major items. Three broad categories are described: component major items, associated support items of equipment, and organization support equipment. These categories focus on equipment as commodities. They do not, in any functional way, describe the nature of the support.

(2) In order to distinguish among the essentiality of equipments, it is necessary to establish the nature of the support. It is then possible to assess that some types of support are more immediate to the performance of the unit mission than others. This has been done as part of the knowledge base construction. Each type of support is considered a Mode of Support. The list of Tier Equipment Modes of Support which emerged from the work is shown in Table 3-3.

Table 3-3. Tier Equipment Modes of Support

Support relationship	Description
Adapt	Connect, attach, link, or otherwise allow supported equipment to operate as intended
Backup	Provide an alternate means of performing function of supported equipment
Control	Direct operation of a supported equipment by orders, manual calculations, or automatic means
Enhance	Operate in conjunction with supported equipment to provide greater flexibility, capability, or efficiency
Exercise	Activate the supported equipment so as to simulate realistic operation for test or training purposes
Initialize	Align, calibrate, adjust supported equipment prior to operational activity
Maintain	Used to service supported equipment to locale of operation and remain in place awaiting next move of equipment
Position	Move supported equipment at locale of operation and remain in place awaiting next move of the equipment
Power	Provide electrical power for sustained operation of supported equipment
Protect	House or cover supported equipment against threatening environmental/hostile conditions
Supply	Move, hold, or issue supplies to supported equipment
Sustain	Provide flow of ammunition, fuel or supplies necessary for sustained operation of supported equipment
Transport	Move supported equipment to locale of operation and then become available to move other equipment

c. Nominal ERC Assignments for Tier Support Equipment. In addition to establishing modes of support for the Tier support equipments, it is useful to consider making ERC assignments based on the particular modes of support involved. This has to be approached carefully since it is at the same time both a desired standardization of the ERC assignment process and an intrusion on the flexibility for ERC assignment, which the expert system was selected to provide. The approach selected is to provide a schedule of "nominal" ERC assignments which are the default assignments for modes when no other usage conditions are present, which would indicate a different ERC should be assigned.

(1) To provide for the nominal ERC assignments of the Tier 1 and Tier 2 support equipments, a distinction is made between the mission-immediate support modes and the mission-proximate support modes. The mission-immediate modes are those which provide support associated with the real time performance of the mission of the unit. The mission-proximate modes are those which provide support associated with assuring the capability of the unit to conduct the mission when it is ordered. By definition, the mission-immediate modes are more closely related to the performance of the unit mission than the mission-proximate modes. Equipments in this support role are assigned an ERC-A. Equipments in the mission-proximate support role are assigned an ERC-B, except for the "exercise" mode, which, by current Army practice, is assigned an ERC-C. There is one additional constraint which needs to be observed in assigning the nominal ERC, namely: the ERC of the Tier 2 equipment may not exceed the ERC of the Tier 1 equipment supported. Thus, if the ERC of the Tier 1 equipment is ERC-A, then the ERC of the Tier 2 may be ERC-A, ERC-B, or ERC-C. Whereas if the ERC of the Tier 1 equipment is ERC-B, then the ERC of the Tier 2 is restricted to ERC-B or ERC-C.

(2) The schedule of nominal ERC assignments which results from these considerations is shown in Table 3-4.

Table 3-4. Nominal ERC Assignments to Tier Equipments

Mode of support	ERC assignment		
	Tier 1 equipment	Tier 2 equipment with	
		Tier 1 at ERC=A	Tier 1 at ERC=B
Mission-immediate support			
Initialize	A	A	B
Control	A	A	B
Power	A	A	B
Position	A	A	B
Adapt	A	A	B
Mission-proximate support			
Transport	B	B	B
Maintain	B	B	B
Supply	B	B	B
Protect	B	B	B
Enhance	B	B	B
Backup	B	--	--
Exercise	C	--	--

d. Unit-level Modes of Support. As shown in Figure 3-1, unit-level support equipment is associated with support of the unit apart from the needs of its specific mission. Broadly stated, this support assures the viability of the unit as an organizational entity, so that the unit mission can be carried out. From this perspective of unit viability, three support modes were identified from consideration of the assets in Army units used in the study. These Unit-level Modes of Support are shown in Table 3-5. No nominal ERC assignments are made for these modes of support. The ERC is dependent upon the context in which the support is provided.

Table 3-5. Unit-level Equipment Modes of Support

Mode of support	Description
Unit protection	Equipment used for both active (weapon based) and passive (shielding based) protection
Unit work environment	Equipment used to establish or maintain working conditions in the unit work area
Unit personnel services	Equipment used to provide personalized support services to the unit personnel or other designated personnel

e. Individual-level Modes of Support. As shown in Figure 3-1, individual-level support equipment is associated with support of individuals in the unit in the performance of their individual duties. The support is provided to allow them to more effectively apply their skills to the task at hand. Again considering the assets in the Army units used in the study, three support modes were identified. These individual-level Modes of Support are shown in Table 3-6. No nominal ERC assignments are made for these modes of support. The ERC is dependent upon the context in which the support is provided.

Table 3-6. Individual-level Equipment Modes of Support

Mode of Support	Description
Situation assessment	Equipment used by an individual to assist with the evaluation of the situation at hand
Skill application	Equipment used by an individual to allow basic skills to be applied to task at hand
Skill productivity	Equipment used by an individual to increase productivity in accomplishing task at hand

3-6. RULE DEVELOPMENT

a. Development Assumptions. In developing the rules for the knowledge base, the following assumptions were made.

- The assessment of the use of the equipment is made at the company level, that is, it is the mission of the company which determines the essentiality of the various support equipment present in the unit.

- Where an equipment supports more than one mission-task of the unit, the principal mission-task, i.e., the one which yields the highest ERC, will be used to establish the contribution. The time employed in such use is not a factor.

- Where an equipment is used to support another equipment in a unit, the ERC of the **equipment supported** will be established and known to the system user before the ERC of the **supporting equipment** is evaluated.

- The equipment support conditions which lead to the assignment of an ERC are contained in a single rule, so that the rationale for the assignment is available for inspection by a user in a single logical entity.

- The equipment support relationship is determined solely by the user of the equipment in the unit, not upon the absolute or relative quantity of the item in the unit.

b. Individual Rules. The individual rules for the system were developed under the assumptions stated, using the equipment classification schema and the associated modes of support to identify individual cases of equipment support. These cases were then expanded and refined using:

- Actual examples of equipment usage present in the sample of units from the heavy division.

- Comments from user from the field knowledge acquisition effort, which extended and clarified the modes of equipment usage.

The rule development was completed in four phases, as described in the following paragraphs.

c. Core Equipment Rules. In the first rule development phase, the core equipment rules were prepared. This involved identifying the mission and mission-task for selected types of Army units, and then assigning to each mission and mission-task combination the core items of equipment and their associated ERC (either ERC-A or ERC-P). The ERC-P assignments were drawn from AR 220-1, Appendix C. The ERC-A assignments for those core equipments critical to the unit, but not identified as pacing items in AR 220-1, were assigned by applying the concept of core equipment in the equipment classification schema. The results of the rule development effort for the core equipments are shown in Appendix H. A representative core equipment rule is shown in Figure 3-2 .

```
IF
          THE UNIT PROPONENT IS FIELD ARTILLERY
 AND      THE FIELD ARTILLERY UNIT MISSION IS TO ENGAGE ENEMY
            WITH INDIRECT FIRES
 AND      THE FIELD ARTILLERY MISSION-TASK IS TO CONDUCT MASSED
            ROCKET FIRES
THEN
          THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
          FA CORE EQUIP: MULTIPLE ROCKET LAUNCHER SYSTEM, ERC-P
```

Figure 3-2. Representative Core Equipment Rule

d. Tier Equipment Rules. In the second rule development phase, the support equipment rules were prepared. This involved considering each mode of support for the tier equipment (Table 3-2) and devising a rule which incorporated all the support factors appropriate to each mode and assigning the appropriate ERC in accordance with the nominal ERC assignment described earlier. For this prototype development, only the nominal ERC (Table 3-3) were assigned. The results of the rule development effort for the tier equipments are shown in Appendix I, Rule Numbers 2 to 26. A representative tier equipment rule is shown in Figure 3-3.

```
IF

          THE PRESENT EQUIPMENT

            DIRECTLY (TIER 1) SUPPORTS A CORE EQUIPMENT

 AND      THE SUPPORT INVOLVES

            CONTROL OF OPERATION OF SUPPORTED EQUIPMENT

 AND      THE CONTROL INVOLVES

            RADIO TRANSMISSION OF ORDERS      OR
            PROCESSING OF CONTROL SIGNALS     OR
            FACILITIES FOR DECISIONMAKING

THEN

          THE SUPPORT RELATIONSHIP IS:  CONTROL CORE EQUIPMENT

 AND      THE READINESS CODE ADVISED IS:  ERC-A

 AND      RULE NUMBER IS GIVEN VALUE T1-02
```

Figure 3-3. Representative Support Equipment Rule

e. Unit-level Equipment Rules. In the third rule development phase, the unit-level equipment rules were prepared. This involved considering each mode of support for the unit-level equipment (Table 3-4) and devising a rule which incorporated all the support factors appropriate to each mode and assigning the appropriate ERC. The results of the rule development effort for the unit-level equipments are shown in Appendix I, Rule Numbers 27 to 38. A representative unit-level equipment rule is shown in Figure 3-4.

```
IF
          THE PRESENT EQUIPMENT SUPPORTS THE UNIT AS A WHOLE

          THE UNIT SUPPORT IS IN THE FORM OF CONCEALMENT OF UNIT
          ASSETS

 AND      THE PRESENT UNIT CONCEALMENT EQUIPMENT IS A SMOKE
          GENERATOR

THEN
          THE SUPPORT RELATIONSHIP IS:  UNIT SUPPORT EQUIP

 AND      THE READINESS CODE ADVISED IS:  ERC-B

 AND      [RULE NUMBER] IS GIVEN THE VALUE "UN-03"
```

Figure 3-4. Representative Unit-level Equipment Rule

f. Individual-level Equipment Rules. In the fourth rule development phase, the individual-level equipment rules were prepared. This involved considering each mode of support for the individual-level equipment (Table 3-5) and devising a rule which incorporated all the support factors appropriate to each mode and assigning the appropriate ERC. The results of the rule development effort for the individual-level equipments are shown in Appendix I, Rule Numbers 39 to 45. A representative individual-level equipment rule is shown in Figure 3-5.

```
IF
          THE PRESENT EQUIPMENT SUPPORTS AN INDIVIDUAL WITHIN UNIT
 AND      THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED ABILITY
          TO ASSESS SITUATION
 AND      NIGHT SURVEILLANCE IS NOT A PRIMARY MISSION REQUIREMENT
 AND      THE PRESENT INDIVIDUAL ASSESSMENT EQUIPMENT IS A NIGHT
          VISION DEVICE

THEN
          THE SUPPORT RELATIONSHIP IS:  INDIVIDUAL SUPPORT EQUIPMENT
 AND      THE READINESS CODE ADVISED IS:  ERC-B
 AND      [RULE NUMBER] IS GIVEN VALUE "IN-02"
```

Figure 3-5. Representative Individual-level Equipment Rule

3-7. KNOWLEDGE BASE STATUS. A summary of the rules developed for each category of equipment support is shown in Table 3-7. As noted in the table, the number of core equipment rules is proportional to the number of mission-tasks defined in the knowledge base, while the number of support equipment rules is proportional to the number of specialized coding situations encountered in the unit types considered. Incorporated into these rules are additional expert system considerations related to goal selection and the use of standardized rule text. These considerations are discussed in the next chapter describing the implementation of the prototype system.

Table 3-7. Prototype Rule Summary

Equipment category	Number of rules	Number of rules proportional to
Core	37	Mission-tasks defined in system
Tier 1 Tier 2 Unit support Individual support	13 12 12 7	Variety of equipment relationships present in units
Total	81	

CHAPTER 4

PROTOTYPE SYSTEM IMPLEMENTATION

4-1. CHAPTER SUMMARY. This chapter describes the implementation of the prototype system. For convenience and clarity, the prototype has been named the ERC ADVISOR, or more simply the ADVISOR. The principal issues in system development were:

- Define the standardized text used in rules for ERC selection.
- Define the goals used in ERC selection.
- Provide for coding of equipment on a unit-by-unit basis, including a summary record of the code assignments for all the items of unit equipment processed.

4-2. STANDARDIZED RULE TEXT. Each rule is constructed using standardized rule text. The rules are constructed in this manner to allow the ADVISOR to clearly differentiate among the degrees of meaning and kinds of meaning carried in the rule statements. For purposes of illustration, a representative rule is shown in Figure 4-1. With reference to this example rule, the following points are made.

```
IF
        THE UNIT PROPONENT IS FIELD ARTILLERY                (Line 1)
 AND    THE FIELD ARTILLERY UNIT MISSION IS TO               (Line 2)
          ENGAGE ENEMY WITH INDIRECT FIRES
 AND    THE FIELD ARTILLERY MISSION-TASK IS TO               (Line 3)
          CONDUCT MASSED ROCKET FIRES
THEN
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:              (Line 4)
 AND    FA CORE EQUIP:  MULTIPLE ROCKET LAUNCHER
          SYSTEM, ERC-P                                      (Line 5)
 AND    RULE NUMBER IS GIVEN VALUE T1-02                     (Line 6)
```

Figure 4-1. Standardized Rule Text

a. Line-by-line Statements. The example rule is seen to have a total of three statements in the IF-part, and three statements in the THEN-part. The statements are linked by "AND" conjunctives. In the IF-part of the rule, the "AND" implies all that the linked statements must be true to satisfy the IF-condition. In the THEN-part, the "AND" implies all the linked statements are asserted to be true as a consequence of the IF-conditions being true.

b. Statement Structure. Three different types of statements are provided in the development tool as shown in Table 4-1.

Table 4-1. Types of Rule Statements

Type	Content
Literal	Alphanumeric string conveying meaning relevant within the rule
Assignment	Equates a value (either numeric or character) to a variable
Semantic	Couples two incomplete text expressions into a complete single expression

An example of the manner in which these types of statements are used in the ADVISOR is shown in Figure 4-1, where:

- Lines 1, 2, and 3 are **semantic** statements identifying the nature of the unit activity
- Line 4 is a **literal** statement used to introduce the information in the next rule
- Line 5 is a **semantic** statement (partitioned at the colon (:)) which identifies the core equipment for the unit activity
- Line 6 is an **assignment** statement to identify the rule used by rule number

All the ADVISOR rules have been implemented using combinations of these statements. In the preparation of the rules using these statements, it was considered essential that the user must be able to understand the rule content. Therefore, all the literal, assignment and semantic statements have been structured to have meaning to the user even if, on occasion, they are introduced for system design purposes.

The purpose and usage of the literal statement (for remarks purposes) and the assignment statement (for computation and control purposes) follow traditional programing practice and will not be discussed

further. The semantic statement, on the other hand, is the principal vehicle for knowledge representation. The structure of these statements is essential to the understanding of the system rule organization and content. The text used in the semantic statement is structured into two parts as follows:

QUALIFIER value

The upper case "QUALIFIER" sets up the first part of the assertion and lower case "value" completes the assertion.

One example of this convention is:

THE UNIT PROPONENT IS field artillery

Another would be:

THE UNIT PROPONENT IS armor

The task in knowledge representation is the construction of "QUALIFIERS" and associated sets of "values" to satisfy all the rule statements of interest. There is, in fact a synergy in the process. The rules suggest the QUALIFIER-value pairs and the construction of the pairs suggest changes or elaborations in the rules.

A complete listing of the semantic statement qualifiers and their associated values, as used in the core equipment rules, is given in Appendix J. A comparable listing for the support equipment rules is given in Appendix K.

c. Rule Identification. The rule identification number "T1-02" is shown in the last line of Figure 4-1. The acronym "T1" identifies it as part of the Tier 1 equipment rule set. The numeric "02" differentiates this rule from others in the Tier 1 rule set.

4-3. SYSTEM GOAL DEFINITION. A feature of particular importance in the system development was the arrangement of the rule information so that all the information pertinent to the ERC selection is displayed at one time to the user. In a more typical rule-based system, the goal selection is based on one or more rules being satisfied. The logic of the choice is thus dependent upon the summation of the logic of the several rules involved. While this information is complete, it may not be readily visible on the system display monitor at one time, as earlier rules scroll off to accommodate later ones. Additionally, where multiple rules are involved, the conclusion of each rule is, in effect, a subgoal along the path to the selection. The user must integrate the meaning of the subgoals to understand the logic flow.

a. To avoid this problem of multiple rules and rule subgoals, it was determined to create a composite rule for each ERC classification situation. In the composite rule, each classification result incorporates all the logic associated with the result. In these circumstances the goal defined for the system is the selection of an ERC (i.e., ERC-A, ERC-P, ERC-B, or ERC-C). Each composite rule is designed to include an ERC selection within its THEN-part. When a composite rule is satisfied, the system goal is satisfied, and the system rule search process is terminated.

b. An ERC selection situation of concern is the case where no composite rule can be located in the system using all the inputs provided by the user. To deal with this situation, provision is made to invoke a (NULL) rule which allows the system the choice that no ERC assignment can be made.

c. To be able to invoke the NULL rule, the system must have a logical link between the NULL rule and all the composite rules in the system. To establish this link, an assignment statement is added to the IF-part of each rule. The assignment statement assigns the variable "ERC ASSIGNMENT" the value "NOT COMPLETED." In a complementary manner, the assignment statement reappears in the THEN-part of the rule with the variable "ERC ASSIGNMENT" reset to the "COMPLETED." This provision within each composite rule is illustrated in Figure 4-2.

d. The NULL rule appears as the last rule in the system knowledge base. It is applied if, at this point in the rule search, the variable "ERC ASSIGNMENT" has the value "NOT COMPLETED." This value would only be the case if none of the composite rules apply, since any use of a composite rule would have changed the value to "COMPLETED." When the NULL rule is invoked, the choice is made that no ERC can be assigned. Refer to Figure 4-3 for the organization and text of the NULL rule.

e. Note in Figure 4-3 the probability value of 1 associated with the goal selection. The expert system always associates a probability, more appropriately referred to as a certainty (to avoid formal probability connotations) to each goal or choice selected. This value represents the confidence that the developer of the system, and presumably the user, places in the rule outcome. In the more typical system development, where real world phenomena are presented in the rules, a measure of confidence (on a scale of, say, 1 to 10), may provide the user with useful insight into the quality of the system advice. For this application, however, certainty is not an issue. The system is asserting an authoritative interpretation of policy. There is no "degree" of correctness. Each code assignment is asserted with certitude and this is reflected in a probability value of 1. If there were any concern for the certainty of a rule, it would have to be resolved by introducing additional rules which would have added statements resolving the dubious point.

```
IF
       [ERC ASSIGNMENT] = "NOT COMPLETED"
 AND       ..........
 AND       ..........                          Coding Conditions
 AND       ..........
THEN
           ..........
 AND       ..........                          Coding Result
 AND       ..........
 AND       [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
```

Figure 4-2. Composite Rule Linkage to NULL Rule

```
IF
       [ERC ASSIGNMENT] = "NOT COMPLETED"
THEN
          THE READINESS CODE ADVISED:    IS NOT POSSIBLE
            Probability = 1
```

Figure 4-3. The System NULL Rule

4-4. PROTOTYPE SYSTEM OPERATION. In the literature of expert systems, emphasis is placed on the achievement of a single goal, with the tacit understanding that the process is repeated as necessary to satisfy subsequent goal problems. Separate provision, outside of the inference processing, must be made to deal with cycling the system as needed to examine all cases of interest. For the prototype development, auxiliary program routines were introduced to make the system capable of repeating its operation as long as desired and producing a summary of its results. As shown in Figure 4-4, this was accomplished by having the ADVISOR request an identification of the name and echelon of the unit under consideration. Only units of company size are assessed. Higher echelon units are rejected with a message explaining that the echelon is inappropriate for assessment. The system then proceeds to deal with the equipment in the unit.

a. Core Equipment Processing. The system, as shown in Figure 4-4, first proceeds to the processing of the core equipment associated with the unit. The user is asked for the overall mission of the unit and then the specific mission-task(s) of the unit. The system then uses the rules in its core equipment knowledge base to identify to the user the unit core equipment(s) and the ERC assigned to this equipment. This identification of the core equipment then serves as the basis for subsequent responses of the user about support relationships of the equipment in the unit.

b. Support Equipment Processing. The system is set up to examine each item of support equipment in the unit in turn. The system, as shown in Figure 4-4, references the support equipment rules. Using these rules, the system asks the user for information on the item of equipment for which the ERC is needed. A short series of queries is used to identify and then refine the nature of the support provided. Where the replies correspond to the conditions of a rule in the knowledge base, an ERC assignment is advised. Failing to find an ERC classification rule, the system defaults to a rule which advises that no ERC can be assigned.

c. Auxiliary Programs. The routines used in the prototype development were coded on an *ad hoc* basis. They were meant to provide a rudimentary capability to cycle system operation from one item of equipment to another (within a unit) and to store the coding results. The routines were written using the BASIC interpreter available on the microcomputer. The functions provided by these routines are necessary to the operation of the system. However, it is anticipated that these functions would be integrated within the expert system in the production version of the system. This being the case, the routines are not documented in this report.

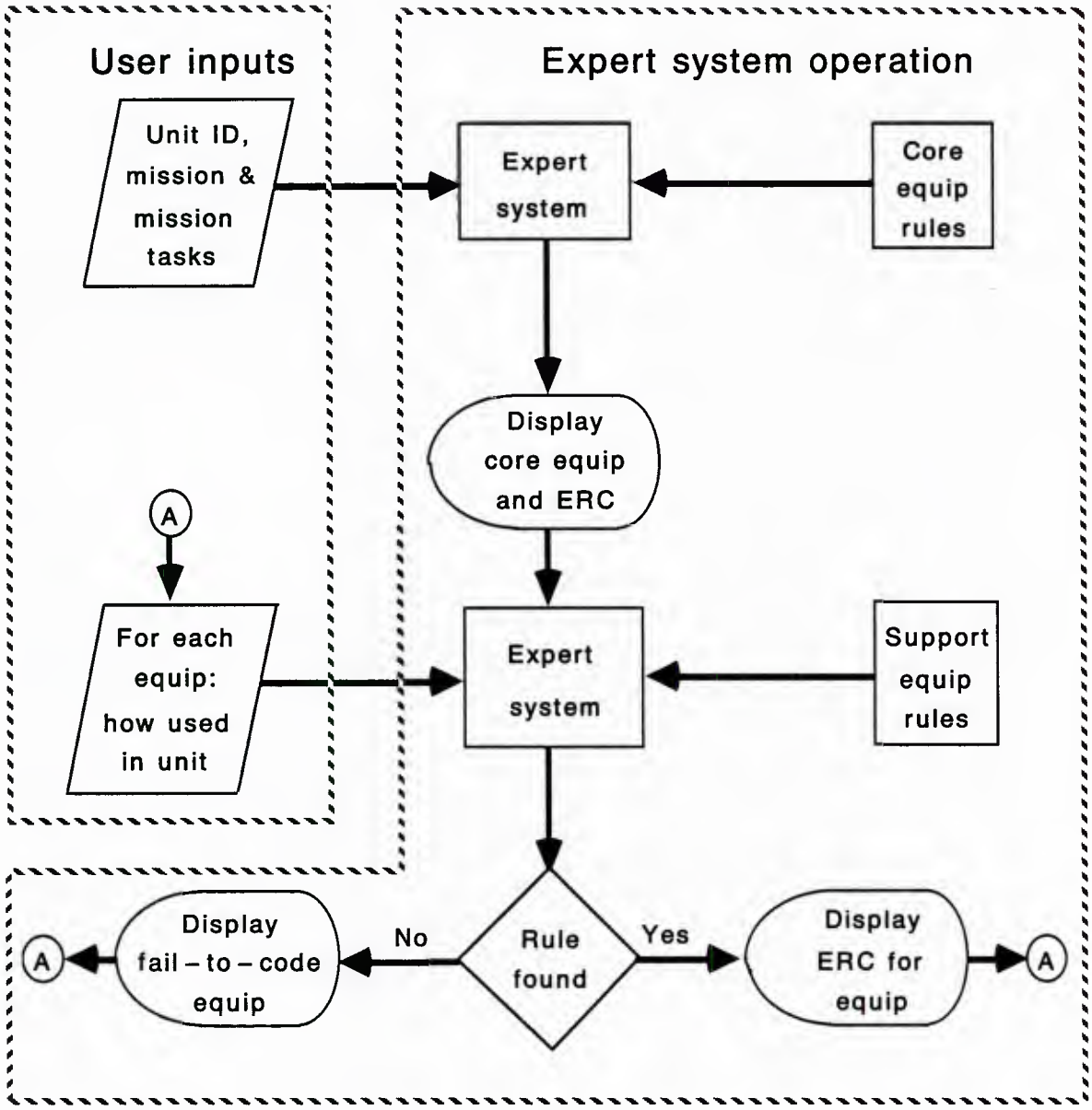

Figure 4-4. Prototype System Operation

4-5. PROTOTYPE SYSTEM STATUS. Development of the prototype system has provided several valuable insights into the issues of system design not originally anticipated, but which have become more apparent as the specific design took shape. These insights are described in the following paragraphs.

a. Handling of Literal Information. Much of the information solicited from the user by the ADVISOR, as shown in rule statements in Appendix H and Appendix I, are menu selections from among allowable alternatives. There are only a few occasions where clear text items (literal information) must be dealt with. The use of literal information in the system is limited to the identification of the unit by name and TOE number, and the identification of each item of equipment by TOE paragraph, LIN, and LIN name. For the prototype, this information was processed outside of the expert system, using auxiliary program routines operated in conjunction with the system. With more experience with rule manipulation, it should be possible to integrate these queries for literals directly into the system.

b. Handling of Multiple Items Within Unit. The basic operation of the ADVISOR is to process, in sequence, the individual LIN within a unit, and to provide for each an ERC assignment. Associated with this processing is the storage of the ERC assignments and the generation of a summary printout of the coding results. For the prototype, this was handled by the auxiliary program routines cited above. For a production version of the system it should be possible to integrate the item cycling directly into the system.

c. Help Screens. In the prototype system, only the system queries are presented to the user; no additional information was available to assist the user with a reply. It would be useful if additional screens of information were available to the user on request; keyed to the particular query at hand (context-sensitive screens). These screens would offer explanations keyed to the queries presently being asked. For a production version of the system it should be possible to integrate these help screens directly into the system.

CHAPTER 5

PROTOTYPE EVALUATION

5-1. CHAPTER SUMMARY. This chapter describes the evaluation of the prototype system. The principal issues involved in the evaluation were as follows:

- Preparation for the evaluation.
- The evaluation activity.
- Technology transfer issues.

5-2. EVALUATION PREPARATION. The planning for the evaluation organized a series of trials of equipment coding using various TOE. A trial consisted of a sample of equipments from a particular TOE, with a total of nine trials included in the evaluation. The effectiveness of the coding was to be determined by the percentage of equipments correctly coded accepting the existing ERC assignments as correct. The detailed plan for the evaluation is shown in Appendix G.

5-3. EVALUATION ACTIVITY. The evaluation plan, as shown in Appendix G, was attempted on site, then discarded, in favor of a more simple demonstration activity due to unanticipated difficulties with both machine performance and user performance, as described in the following paragraphs.

a. Machine Performance

(1) The machine at the site (TRADOC HQ) was a microcomputer workstation with 256K memory using MS-DOS. System development at CAA had used a 512K machine with PC-DOS. A specific test for memory size compatibility was made at CAA, by installation of a RAM disk on the 512K machine to reduce the available memory to approximate that available in the field. The DOS operating system differences were not considered significant.

(2) Testing at CAA, however, failed to reveal that while the expert system and its rules loaded successfully, loading of the auxiliary programs was not completed due to insufficient memory. The error message associated with this failure did not report the failure to load, but instead indicated a failure to find the needed programs during expert system operation. The error message flashed briefly on the CAA machine during the memory trials to establish the fit for the expert system, but its significance was not recognized. However, on the smaller (and slower) field workstation, the message was readily apparent, and its consequence was immediately recognized. The field workstation memory could accommodate the expert system, as demonstrated in the CAA testing, but not the auxiliary programs which must also reside in memory during execution.

(3) A workstation with larger memory was obtained at the field site and the evaluation continued. Two additional problems soon became apparent. The first problem was the slowness of the overall system. This was due primarily to the execution of the auxiliary programs. Both the need to load different programs at different times from diskettes and the need to interpret the program (BASIC) code made the time spent in cycling from one equipment to another excessive and objectionable to the users. The second problem was the need to switch from using the Microsoft BASIC interpreter used on the CAA machine to the GW BASIC interpreter used on the TRADOC workstations. The Microsoft BASIC brought to the site would not operate. A switch was made to the GW BASIC. It ran successfully--up to the point where printout was called for, at which point it failed. With this extensive set of difficulties with the BASIC programs, it was decided to drop them from the system and replace the automatic audit trail capability they provided with manual recordkeeping for the test. The necessary changes were made and the system prepared for trials by the users.

(4) The basic TRADOC workstation (WYSE - 256K) was initially considered as the likely host for the production version of the expert system. It is generally available within the TRADOC community, and it would therefore be the most convenient means of providing access to the system. It proved to be inadequate, however, primarily in memory storage. Its response is adequate, but not as good as that achievable on later generation machines. A memory expansion from the present 256K is needed for the machine to handle either the present prototype or the planned production configuration of the system. TRADOC has indicated that such an expansion of the memory is possible.

b. User Performance

(1) Initial trials with the system indicated that the users had difficulty in responding to the system queries for information. The basic concepts of classifying support equipment into TIER 1, TIER 2, Unit-level and Individual-level posed difficulties of interpretation not previously identified as a problem. More fundamentally, this terminology was not part of the standard logistics support vocabulary. Users were observed making an effort to adjust the new terms to their perspective, rather than accepting the (new) concept of support categories being offered.

(2) Additionally, there appeared to be an expectation on the part of the users that the ERC ADVISOR would be similar in philosophy and operation to the Direct Combat Probability Codes (DCPC) system currently in use as part of the TOE documentation process. This system is used to identify the combat exposure of a unit, as it relates to the assignment of female personnel to noncombat military occupational speciality (MOS), in units in forward battle positions. The systems, however, present the user with significantly different situations, as shown in Table 5-1.

Table 5-1. Contrast Between Systems

DCPC System	ERC Advisor
Uses familiar unit-position terminology	Uses unfamiliar support relationship terminology
Asks all its questions at once	Asks its questions sequentially
Does not (necessarily) have to address each MOS	Does have to address each equipment

c. **Demonstration Alternative.** As a consequence of the machine and user difficulties, the plan to systematically arrive at a quantitative effectiveness measure of performance was not carried out. In place of this approach, a demonstration of the system was conducted on an informal (spontaneous) basis for the participating action officers and (separately for) the management personnel, within the scheduled test time remaining.

5-4. DEMONSTRATION ACTIVITY. The demonstration activity is described in Appendix L and summarized in the following paragraphs.

a. The demonstration activity focused on design, operation and current status of the system, using actual system inputs and outputs. The procedure for demonstrating the system was rule-oriented rather than TOE-oriented. That is, rather than selecting an equipment from a TOE and finding out which rule was appropriate to the ERC classification, a rule was selected and responses presented to the system queries to cause the rule to be used. This approach expedited the demonstration within the time available, since no particular TOE context was involved and the specifics of a particular equipment use, relative to a TOE, could be dispensed with.

b. The scale of the demonstration, in terms of the number of rules presented, is summarized in Table 5-2.

Table 5-2. Scale of Demonstration Activity

Rule type	Number of rules in system	Number of rules demonstrated
Core equipment	37	2
Support equipment		
Tier 1	13	7
Tier 2	12	2
Unit-level	12	3
Individual-level	7	2
Rule total	81	16

c. As shown in Table 5-2, the rules, by type, were demonstrated in varying degrees, as discussed below.

(1) The core equipment rules presented no conceptual difficulties. They involved cataloging unit mission and mission tasks and associating core equipments with each combination of mission and mission-task. This information was derived directly from existing documentation. It was recognized as readily available and required only the briefest of illustration to indicate the manner in which the documentation is reflected in the rule structure.

(2) Emphasis was placed on the demonstration of the support equipment rules, particularly the Tier 1 support equipment. These rules illustrate the various modes of mission-related support (see Chapter 3) organized into the rules of the expert system. Of the 13 support modes present in the system, 7 were demonstrated.

(3) The Tier 2 support equipment rules are largely similar to the Tier 1 rules, except that the ERC of the supported equipment is taken into account in assigning the ERC of the equipment being considered by the system. Given the similarity between the Tier 1 support equipment rules and the Tier 2 support equipment rules, only 2 out of the 12 Tier 2 support equipment rules were demonstrated.

(4) Both the Unit-level support equipment and the Individual-level support equipment rules were considered largely self-explanatory. A sample of 3 out of 12 Unit-level support equipment rules, and 2 out of 7 Individual-level support equipment rules were used to illustrate the rule structure.

d. The specific rules presented in the demonstration activity are identified in Appendix L. The actual rules may be inspected in Appendix H (Core Equipment Rules) and Appendix I (Support Equipment Rules).

e. The comments of the observers of the demonstration are summarized in the following:

(1) System Design

(a) No changes were suggested to the basic system design, namely, the equipment classification schema or the equipment support relationships described in Chapter 3.

(b) The need for revisions to the statements in some rules was pointed by the observers of the demonstration, to either clarify the support conditions being described or include additional support conditions.

(c) The system terminology problem, which was a source of initial difficulty, was felt to be manageable by both training in system use and some simplification of the system nomenclature.

(2) System Operation

(a) There had been an initial criticism of the slowness of response of the system. This was corrected by deleting the programing associated with report generation (for an audit trail). The resulting increase in speed was considered by the observers as satisfactory.

(b) The continued need for a report generation capability was affirmed by the observers.

(3) System Status

(a) The observers expressed satisfaction with the potential for ERC assignment demonstrated by the system. They endorsed its continued development in a follow-on effort.

(b) The observers affirmed the need to conduct a formal validation of the system, as part of the follow-on effort, to assure the integrity of the fielded system.

f. The TRADOC position, expressing satisfaction with the demonstration, was subsequently expressed at the meeting of the Study Advisory Group and recorded in the group minutes (see Appendix M).

5-5. TECHNOLOGY TRANSFER ISSUES. Based on results of the evaluation, two distinct issues associated with the transfer of the ADVISOR technology into the TRADOC environment were identified. The first technology transfer issue is the extent to which the user can understand the system queries for information. The second technology transfer issue is the manner of contribution of ADVISOR in the work environment.

a. User Understanding. The user is presumed by the ADVISOR to have complete knowledge of the uses of equipment in the unit. This presumption is inherent in the nature of the task of TOE documentation. It is not possible to account for the diversity of equipment within a unit without being aware of the uses to which the equipment is put. The present difficulty is that equipment use, and more specifically the manner in which equipments support each other, is based on a broad concept of integrated logistics support (Ref 3) which emphasizes the procurement and fielding of equipment, not the functional support relationships needed to establish priorities. The ERC ADVISOR seeks to establish support relationships from the manner in which the equipments are functionally related to each other. The support relationship terminology used by the ADVISOR may be unfamiliar, in that it goes beyond the current logistics support vocabulary. The basic design problem is to bring about a match between the manner in which the user understands relationships, and the manner in which the system defines these relationships. To achieve the match, a twofold approach is needed. First, the ADVISOR must be adjusted to present its queries about types of support in the most understandable form possible. Second, the user must be trained to think in terms of types of equipment support. A blend of these approaches can be achieved by use of the ADVISOR itself, as part of TOE developer training. The ADVISOR could be used in exercises by new users to assess sample TOE. Known coding results could be then compared with the individual's performance and used to measure the extent to which the types of equipment support relationships have become part of the developer's understanding of the functioning of equipment within units.

b. Manner of Contribution. Use of the ERC ADVISOR (in its fully developed form) is anticipated at both the TOE developer level and the TOE manager level.

(1) At the TOE developer level, the ERC ADVISOR will directly assist with the coding process. The extent of the use of the system will be related to the experience level of the individual involved. TRADOC anticipates that those less experienced will seek access to the system more frequently than those experienced in TOE documentation. In any event, controversial coding calls can be defended by citing the rule employed. Any discussion can then proceed from a consideration of the specific rule leading to the assignment.

(2) At the TOE manager level, TRADOC anticipates that the ERC ADVISOR will simplify the ERC assignment review by providing a coding standard across the various TOE documentation activities (service schools). It will provide a convenient reference during TOE reviews of questionable coding calls. TRADOC has also commented that the system should also be used as a training aid, either in formal classroom settings or in on-the-job training. Finally, it was recognized that the routine availability of the system in the workplace should stabilize the institutional knowledge within the TOE development organizations and help preserve the continuity in the coding process during periods of personnel turnover.

CHAPTER 6

RESULTS

6-1. CHAPTER SUMMARY. This chapter describes the results of the effort to assess the feasibility of using expert system technology to assist in the assignment of equipment readiness codes. The results are in the form of:

- Responses to the essential elements of analysis.
- Observations arising from the development effort.

6-2. ESSENTIAL ELEMENTS OF ANALYSIS (EEA). The research was guided by five EEA, as described in the study directive (Appendix B). Summary answers to these questions are as follows:

a. Can the current Army policies and procedures for ERC assignment be reduced to a structured form amenable to automation in an expert system?

Response: Yes. A structure which relates the equipment to the mission of the unit and the manner in which the equipment supports the unit mission has been developed. A prototype expert system of 81 rules has been constructed using the schema which generates ERC codes for a representative set of equipment coding cases associated with unit types selected from the Army heavy division.

b. Can those aspects of ERC assignment derived from experience and from informally acquired information be adequately identified and represented in an expert system?

Response: Yes. The 81 rules cited above have mediating conditions derived from user practice affecting equipment readiness code assignments.

c. As a measure of the expert system validity, can the developed prototype expert system assign ERC to unit equipments, to the satisfaction of TOE developers?

Response: TRADOC management personnel participating in the system evaluation activity were satisfied with the system and so reported to the Study Advisory Group. Testing of the system, however, disclosed that users (TRADOC staff officers) had difficulty with selection among the choices presented by the system and, as a consequence, quantitative test results were not obtained. The difficulties are with some system qualifiers used to differentiate among types of equipment support. This terminology is not part of standard logistics support vocabulary. TRADOC considers these terminology difficulties significant but not critical to the system feasibility demonstration and they will be addressed in the production version of the system.

d. What characteristics of expert system development tools and their host computers are most significant to their use in the assignment of ERC in the combat development environment?

Response: The system should be available on an individualized basis to TOE developers. The workstations must have a fast (no perceptible delay) response time and generate a printout of coding results to serve as an audit trail on the coding process. The present TRADOC workstations (WYSE - 256K) have an acceptable response time, but insufficient memory to support current audit trail programs. A workstation with a larger memory is indicated. TRADOC considers such an upgrade possible.

e. What are the principal development issues in extending the prototype expert system to general ERC assignment in the combat development environment?

Response:

(a) There must be a tight integration of development and validation of the system. Part of the development will involve clarifying and defining equipment support relations which are not currently a part of logistics support terminology. Users providing input to the development process are in a position to assist in the selection of appropriate terminology to express the necessary distinctions among various types of support. The effectiveness of the terminology should then be itself tested as part of the validation of the overall system. The preferred approach would be to proceed with the system development in phases. Each phase would focus on a particular cluster of unit types showing similar equipment support situations. Development and validation would be completed for each cluster before moving to the next.

(b) In terms of technical development of the production version of the system, rule development and rule evaluation must be conducted in a more structured setting than that achieved during the prototype effort. These activities should be conducted in workshops remote from the daily work environment. Special procedures need to be developed to assure maximum productive use of the workshop time.

(c) In terms of the management issues involved, both school personnel and technical support personnel must be made available on a dedicated basis to participate in the development effort. Without such involvement, the system cannot be successfully integrated into the working environment. After the development effort, management must evidence a commitment. This can be accomplished in several ways. One way is to provide training in system use as part of ongoing TOE developer workshops. Another way is to mandate documentation of the system use, by citing the ADVISOR rules used for equipment coding in the TOE "narrative summary"--the TOE justification document which accompanies the completed TOE through the review process.

6-3. OBSERVATIONS

a. The prototype development activity included forwarding of draft user documentation on the system for user review. One comment received advised that the documentation, as prepared, did not conform to the current automated data processing (ADP) documentation standards (Ref 2). This failure to conform was not an oversight, but reflected a necessary departure from the standards to adequately document the system. The program structure and user interfaces of this system and, more generally, the range of artificial intelligence systems now being considered, are markedly different than systems using the more traditional numerical (ADP) processing. To allow effective documentation to be introduced into the field, as these systems are developed, new standards must be developed. As a minimum, an appropriate procedure must be established for granting waivers to the existing standards.

b. The expert system software used for the prototype development is a proprietary package, as are all commercially available microcomputer software. As such, it is not government property, but is under lease to the government. In the case of the EXSYS package, a runtime license is available which will allow distribution of unlimited copies of the developed program for a nominal fee ($600). However, program design remains under the control of the vendor and support (a least at this time) is limited to informal, telephonic assistance. No on-site support or other guaranteed assistance is available.

c. The current TRADOC workstations are first generation microcomputers with limited memory and speed. In the short term, they are the workstations of choice, simply because they are available throughout TRADOC and will thus facilitate user exposure to the system. In the longer term, however, more powerful machines should be made available. For the immediate situation, a memory upgrade is needed to allow the fully developed system to operate.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Director

Mr. James J. Connelly, Force Systems Directorate

b. Team Members

Ms. Rose A. Brown
Mr. Kirk S. Reed

c. Other Contributors

Mr. Howard E. Whitehead

2. PRODUCT REVIEW BOARD

Mr. Ronald J. Iekel, Chairman
MAJ Tommy E. Shook
MAJ Michael C. Schulze
Ms. Laurie A. Latchford

3. EXTERNAL CONTRIBUTORS

a. Study Advisory Group

LTC Connie Brown, Office of the Deputy Chief of Staff for Operations and Plans (Study Sponsor POC)
Mr. Donald Feeney, Office of the Deputy Chief of Staff for Logistics
Mr. Isaac Greene, Office of the Deputy of Staff for Logistics
Mr. Charles Hall, Office of the Deputy Chief of Staff for Logistics
LTC John McGarrihan, Army Artificial Intelligence Center
MAJ Charles Snow, Office of the Deputy Chief of Staff for Force Development
Mr. Dom Vittorini, US Army Training and Doctrine Command

b. Other Contributors

Mr. Joseph Richards, US Army Training and Doctrine Command
Mr. William Randolph, US Army Training and Doctrine Command

APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, DC 20310 - 04

REPLY TO ATTENTION OF

14 MAY 1986

DAMO-ODR

SUBJECT: Expert System Initiative in Logistic Readiness

Director
US Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

1. PURPOSE. This directive provides tasking, direction and guidance for the conduct of the subject study.

2. BACKGROUND. Logistic readiness requires that a unit have the equipment and resources necessary to carry out its mission. The variety of equipment in a unit makes it critical to distinguish among those equipments which make an essential contribution to the mission and those which make only an auxiliary or administrative contribution. The applicable readiness regulation (AR 220-1), does not provide sufficient guidance to allow the necessary differentiation to be made on a uniform and consistent basis by the activities assigning these classifications in the form of Equipment Readiness Codes (ERC).

There is a need, therefore, to bring increased systemization to the classification process and, considering the volume and diversity of equipment involved, implement such a system on an automated basis. It may be possible to meet these needs for systemization and automation using the emerging technology of expert systems. These systems provide expert advice by drawing upon a knowledge base containing an extensive set of rules dealing with factors which influence selections, such as equipment classification.

Given the newness of this technology, it is proposed to conduct an exploration of the feasibility of the expert system approach to the ERC classification problem. It is anticipated that this exploration will result in a prototype expert system which can be expanded in capability to support subsequent work on the FY86 Study Program Proposal Number DAMO-G-005, dealing with the general classification problem in assigning and using ERC.

3. DA STAFF PROPONENT.

a. Sponsor: ODCSOPS

b. Sponsor Study Director: LTC(P) Harry Fleming, AUTOVON 227-5730

DAMO-ODR
SUBJECT: Expert System Initiative in Logistic Readiness

4. STUDY AGENCY. US Army Concepts Analysis Agency (CAA)

5. TERMS OF REFERENCE.

a. Terminology. The following terms, associated with expert systems technology, are provided for reference.

(1) Expert system - A computer program that uses knowledge and inference procedures to solve problems that normally require human expertise for their solution. The knowledge of an expert system consists of facts and heuristics. The "facts" constitute a body of information which is widely shared, publicly available, and generally agreed upon by the experts in a field. The "heuristics" are mostly private, little discussed rules of good judgement that characterize expert-level decision making in the field.

(2) Knowledge base - The specific collection of knowledge, (facts and heuristics) structured as a set of rules, within an expert system.

(3) Domain - The nature and extent of the subject matter captured in the knowledge base, that is the area of expertise of the system.

(4) Inference - The process by which an expert system works through the set of rules in its knowledge base to a conclusion, using information accumulated during the process to select the next rule to be evaluated.

b. Scope. For the purposes of the feasibility exploration, the domain (scope) of the prototype expert system will be established using a representative sector of expertise within the combat developments community and within this sector a specific set of units (TOE). The specific TOEs to be used by the study will be those associated with the company-size units within the Heavy Division, including the headquarters elements.

c. Objective. Develop a prototype expert system which demonstrates the feasibilty of such a system to assist combat developers in the assignment of ERC during the TOE development process.

d. Timeframe. Current

e. Assumption. A commercially available, microcomputer based, expert system development tool will be appropriate and adequate to the development process.

f. Essential Elements of Analysis.

(1) Can the current Army policies and procedures for ERC assignment be reduced to a structured form amendable to automation

in an expert system?

(2) Can those aspects of ERC assignment derived from experience and from informally acquired information be adequately identified and represented in an expert system?

(3) As a measure of the expert system validity, can the developed prototype expert system assign ERC to unit equipments, to the satisfaction of TOE developers?

(4) What characteristics of expert system development tools and their host computers are most significant to their use in the assignment of ERC in the combat development environment?

(5) What are the principal development issues in extending the prototype expert system to general ERC assignment in the combat development environment?

g. Anticipated Benefits.

(1) The feasibility of using an expert system to assist in the assignment of ERCs will be demonstrated.

(2) Use of such a system will facilitate the consistent application of policy and practice in the assignment of ERCs.

(3) A working tool will be available to combat developers for orientation to and familiarization with expert systems technology.

(4) Inherent in the expert system approach is the capability to display and comment on the rules used in the classification process. Using this capability, the system can be used by successive (equipment-knowledgeable) levels in the Army to review individual ERC classifications generated by the system.

h. Limitations. The prototype development is a limited effort to establish feasibility. It may not fully identify and incorporate all the relevant issues of ERC assignment in the TOE examined or capture equipment classification issues significant to TOE not examined. However, the inherent flexibility of the expert system technology to accommodate knowledge update will allow for such changes as they are identified in the subsequent production version of the system.

6. RESPONSIBILITIES.

a. Study Agency.

(1) Organize, resource and conduct the study.

(2) Prepare a study report responding to the essential elements of analysis and documenting the prototype system design.

b. Study Proponent.

(1) Provide necessary coordinations for the study with command and field activities.

(2) Constitute and convene a Study Advisory Group (SAG) as appropriate.

(3) Prepare an evaluation of the study results IAW AR 5-5 and DACS-DMO letter of 19 October 1983.

c. TRADOC HQS.

(1) Authorize and coordinate study access to the relevant integration center and service school TOE development specialists who will describe, discuss and illustrate their activities in making ERC assignments.

(2) Authorize and coordinate participation in evaluations of the prototype knowledge base (equipment classification rules) and the working prototype expert system developed using the above TRADOC input.

d. Other Participants. The remaining participants, as represented on the SAG, will provide an ARSTAF/command perspective on the work in terms of its overall contribution to logistic readiness.

7. REFERENCES.

a. Administrative.

(1) AR 5-5, Army Studies and Analysis

(2) AR 10-38, Organization and Functions, US Army Concepts Analysis Agency.

(3) Letter, DACS-DMO, Subject: Responsibility of Study Performing and Study Sponsoring Organizations, 19 October 1983.

b. Substantive.

(1) Office of the Deputy Chief of Staff for Operations and Plans, FY86 Army Study Program Proposal, Equipment Readiness Codes, DAMO-G-005.

(2) AR 220-1, Unit Status Reporting, dated 1 June 1981 and its pending draft revision.

DAMO-ODR
SUBJECT: Expert System Initiative in Logistic Readiness

8. ADMINISTRATION

a. Funding. Funds required for TDY, per diem, overtime, etc., are the responsibility of each participant organization.

b. The cost of the expert system development tool(s) used for the generation of the prototype system will be borne by the Study Agency. In addition, the Study Agency will procure a runtime license, as needed, to permit distribution and operation of the prototype system, at selected field locations, for prototype evaluation purposes. The cost of such runtime license is not to exceed $600. Any additional licensing associated with subsequent development and use of the system will be identified in the study report and such licensing costs are not a part of this study.

c. Computing Resources. TRADOC HQS will arrange for access to existing microcomputer (PC compatible) facilities at one or more of the combat development activities participating in the study, to permit file operation of the prototype system for development and evaluation purposes. The microcomputer capability needed is anticipated to be that associated with a spreadsheet or data base program.

d. Milestone schedule. See Enclosure 1.

e. Coordination Procedure. Direct coordination is authorized between CAA and TRADOC HQS, the integration centers and the service schools.

f. Study Advisory Group. The study proponent will designate a Study Advisory Group (SAG) with membership from DAMO-FDR, DALO-PLF, DALO-PLR, DAIM-DOA, TRADOC HQS, the integration centers and the service schools.

g. Study Coordination. This tasking directive has been coordinated with CAA IAW AR 10-38, paragraph 6.

FOR THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS:

William C Moore

Enclosure

WILLIAM C. MOORE
Major General, GS
Director of Operations,
Readiness and Mobilization

Study Milestones

Milestone	Date
Prototype knowledge base completed	30 May 1986
Field evaluation of knowledge base completed	30 June 1986
Prototype development completed	31 July 1986
Field evaluation of prototype completed	29 August 1986
Study Report (draft) completed	30 September 1986

APPENDIX C

REFERENCES

DEPARTMENT OF THE ARMY

Department of the Army (DA) Publications

1. AR 220-1, Unit Status Reporting, 16 September 1986

2. TB 18-111, Army Automation Technical Documentation, 22 April 1983

US Army Training and Doctrine Command

3. HDBK 700-1.1-83, System Support Equipment

MISCELLANEOUS

4. Cutter Information Corp., Expert System in the Workplace, 1986

5. Cutter Information Corp., Expert Systems Building Tools, Expert System Strategies, March 1986

6. Harmon, Paul and King, David, Expert System, Wiley Press, 1985

7. Waterman, Donald A., A Guide to Expert Systems, Addison-Wesley Publishing Company, 1985

APPENDIX D

EQUIPMENT READINESS CODE CONCEPT

D-1. INTRODUCTION. This appendix reproduces the applicable portion of the Army regulation dealing with Equipment Readiness Codes, namely AR 220-1, Unit Status Reporting; specifically Appendix B, Equipment Readiness Codes. It is provided as a convenience to the reader in reviewing the official Army statement on the assignment of equipment readiness codes.

a. The codes are described in the regulation by means of a basic definition, general guidelines and the designation of codes for specific equipments. The resultant exposition, however, is not totally adequate because not all cases of equipment utilization are covered, and the phrase "variable coding" is used where the same item has varying uses in the unit.

b. The lack of sufficient guidance permits a variability in interpretation of equipment essentiality to the unit mission. This gets reflected in the codes assigned to unit equipment by combat development personnel and then documented in the unit Table of Organization and Equipment. The assigned codes must be reviewed and approved by combat development headquarters activities who must also interpret of the coding guidance.

c. The codes are then automated into machine readable form. The automated code, in conjunction with the priority of the unit as defined in the Department of the Army Master Priority List (DAMPL), is then employed in the Total Army Equipment Data Processing (TAEDP) system. This system is run semiannually to allocate equipment to Army units world wide. Via this route of documentation and processing, a misinterpretation of the coding guidance can influence the readiness of the fielded force by inappropriately allocating resources, which already may be in short supply.

D-2. REGULATION APPLICABLE TO EQUIPMENT READINESS CODES. A reproduction of the Equipment Readiness Codes portion of the applicable regulation appears in the following pages.

Appendix B
Equipment Readiness Codes

B–1. Equipment readiness codes
Every equipment line item number (LIN) in a TOE/MTOE is annotated with an equipment readiness code (ERC). The annotation is a single alpha code in the ERC column of the TOE/MTOE which is identified in table B–1.

Table B–1
Equipment readiness code and readiness identification

ERC: A or P **Readiness identification:** Primary weapons and equipment (PWE)
ERC: B **Readiness identification:** Auxiliary equipment (AE)
ERC: C **Readiness identification:** Administrative support equipment (ASE)

B–2. ERC definitions
a. ERC–A or ERC–P (PWE). ERC–A equipment is essential to and is employed directly in the accomplishment of assigned operational missions and/or directly provides the principal means to generate unit capabilities stated in a unit's TOE/MTOE. ERC–A equipment is unit status reportable. ERC–P items are ERC–A equipments that are also pacing items (app C).

b. ERC–B (AE). Equipment which supplements primary equipment or takes the place of primary equipment should it become inoperative. This term includes equipment other than primary but of greater importance than administrative support equipment.

c. ERC–C (ASE). Equipment supportive to the performance of assigned operational missions and tasks.

B–3. Coding guidelines
a. If a LIN identified as ERC–A or ERC–P (PWE), all subcomponents listed by separate LIN will be considered ERC–A; for example, radio installation kits for radios. However, items will not be counted as pacing items unless they are specifically designated with a "P" or listed in appendix C as a pacing item (para C–2).

b. Depending on the mission and nature of a unit, wheeled and tracked vehicles and their subsystems may be coded ERC–B (AE). For example, a ¼–ton truck with radios may be coded as ERC–B in the Headquarters and Headquarters Company (HHC) of a mechanized battalion while in a nonmechanized battalion it would probably be coded ERC–A. In a mechanized unit, tracked vehicles are normally the principal items used for command and control of tactical operations.

c. The assignment of a readiness code to an item of equipment in any given TOE/MTOE is based on the essentiality of that item to the primary mission of the unit. Like items in a unit can have a different degree of essentiality. For example, within a TOE/MTOE it may be appropriate to designate the commander's radio as ERC–A and the adjutant's as ERC–B.

B–4. Designating ERCs
a. HQ TRADOC will use the guidelines in paragraphs B–1 through B–3 and examples in table B–2 to assign readiness codes to TOE equipment items.

b. Major Army commands will code MTOE using codes in TOE. Use of an ERC on an MTOE that is different from that on the TOE is not authorized without approval from HQDA (DAMO–ODR).

c. Readiness coding is to be expanded to TDA units in the future (paras 3–7*a*(2) and 3–8*a*(2)).

d. Table B–2 provides equipment readiness code examples. They are not all encompassing but reflect the need to discriminate by mission essentiality and between like equipment. ERC–A items that are also pacing items will be identified by a "P" on TOEs/MTOEs (para C–2). Pacing items are currently not coded on TOEs/MTOEs; however, actions are being taken to accomplish this action (para C–2).

Table B–2
Equipment readiness code examples

Equipment	ERC
a. *Communications equipment.*	
(1) FM and HF voice command and control radios.	Tactical operations nets for maneuver brigades, combat divisions, corps, and other type major command HQ which direct tactical operations; combat arms units (see note); and MP units, ERC–A. Also ERC–A, specific radios of supporting commanders which by doctrine are required to be in a command net; for example, division support commander (DISCOM) and forward support battalion (FSB) commander. In all other units, code B.
(2) FM and HF admin log net radios.	In all units, code B.
(3) Wire and associated equipment.	In signal units, where wire and associated equipment supports an ERC–A system(s), code A. In all other units, code B.
(4) Radio teletypewriters (RATT).	In all units, code B (unless it is the primary means of communication)
(5) Multichannel radio equipment.	In signal units, code A. In all others, code B.
(6) COMSEC equipment.	Code will match radio supported.
(7) Radars.	In all units with primary mission of surveillance, code A. In all others, code B.
(8) Installation and accessory equipment for radios and COMSEC equipment.	Code will match radio supported.
b. *Weapons.*	
(1) Artillery weapons.	In all units, code A (except ceremonial).
(2) Individual weapons.	In combat arms and MP units, code A. In all other units, code B.
(3) Crew served weapons (Caliber .50 and under).	In combat arms and MP units, code A. In all other units, code B.
(4) Bayonets.	In infantry and Special Forces units, code A. In all other units, code B.
c. *Vehicles.*	
(1) Command and control vehicles.	In all units, code A (like vehicles in a unit may require variable coding; for example, commander's vehicle code A, chaplain's code B).
(2) Combat tracked vehicles.	In all units, code A.
(3) Recovery vehicles.	In maintenance units, code A. In all others, code B.
(4) Vehicles, to include fuel tank trailers and cargo trailers, used primarily for transport of POL or ammunition.	In all units, code A.
(5) Vehicles that are used to power ERC–A radios.	In all units, code A.
(6) Other vehicles.	All units, variable coding.
d. *Generators.*	If a sole power source for a code A item, use code A. In all other units, code B.
e. *Night vision devices.*	In all units with a primary mission which requires night surveillance (Infantry, Armor, Aviation, and MP), code A. In all other units, code B.
f. *Unit maintenance equipment.*	In all units, code B.
g. *Camouflage nets.*	In all units, code C.
h. *NBC defense equipment.*	
(1) Individual protective mask.	In all units, code A.
(2) Decontamination Apparatus, PDDA and LDS.	In all medical units whose primary mission is decon, Code A. In all other units, code B.
(3) Portable decontaminating apparatus.	In all units, code B.
(4) Alarms.	
(a) Detectors.	In NBC reconnaissance units, code A. In all other units, code B.
(b) Monitors.	In NBC reconnaissance, decontamination, and medical units, code A. In all other units, code B.
(5) Radiacmeters.	In NBC and other recon units, code A. In all other units, code B.
(6) Dosimeters and chargers.	In all units, code B.
(7) Collective protection.	In medical units, code A. In all other units, code B.
(8) Smoke generators.	In units whose primary mission is smoke generation, code A. In all other units, code B.
(9) Gas particulate filter units (GPFU).	In all units, code A.
i. *ADPE major item such as AN/MY4Q–4.*	In all units, code A.
j. *Petroleum handling equipment.*	
(1) Petroleum laboratories.	In all petroleum lab units, code A. In all other units, code B.
(2) Collapsible POL storage bags, 10,000 gal and larger.	In all supply and service (S&S), supply and transportation (S&T), and POL supply operating companies, code A. In all other units, code B.
k. *Carpenter, pioneer, and demolition sets.*	Combat engineer and Special Operations Forces, code A. In all other units, code B.
l. *Wrist watches.*	In all units, code C.
m. *Band instruments.*	In all units, code B.
n. *Mess equipment.*	In all units, code C.

Note:
Combat arms units are: infantry, armor, field artillery, Special Forces, engineer, air defense artillery, and aviation.

B–5. Recommending changes
Submit recommended ERC changes for specific unit LIN, with justification, through channels to Commander, TRADOC, ATTN: ATCD–OT, Fort Monroe, VA 23651.

APPENDIX E

PACING ITEM DEFINITION

E-1. **INTRODUCTION.** This appendix reproduces the applicable portion of the Army regulation dealing with Pacing Items of Equipment, namely AR 220-1, Unit Status Reporting, and specifically Appendix C, Pacing Items of Equipment. It is provided as a convenience to the reader in reviewing the official Army statement on the assignment of pacing items.

a. The pacing items of equipment in a unit are a subset of those essential items coded as ERC-level "A". The pacing items are considered especially critical and are placed in a special category designated as ERC-level "P". The special category is introduced because of the manner in which unit status is reported under the regulation.

b. The regulation calls for the unit status to be reported on a percentage-of-equipment onhand basis. With this percentage approach, an especially critical item (e.g., a tank in a tank company) could be absent and, provided that all other equipment were present, the unit could be reported as ready. To preclude this type of circumstance, while retaining the percentage method of readiness computation, the pacing item concept was introduced. It specifically identifies the equipment which must be reported separately, outside of the percentage criteria.

c. The regulation has an extensive table (Table C-1), listing the pacing items of equipment for various type of units. It is used by the service schools as the definitive list of such equipment. However, the text of the regulation (para C-4), refers to the table as containing "examples" of the pacing equipment. The ongoing development of the expert system should force a resolution of this disparate perception between the regulation proponents and the user community.

E-2. **REGULATION APPLICABLE TO PACING ITEMS.** A reproduction of the pacing item portion of the applicable regulation appears in the following pages.

Appendix C
Pacing Items of Equipment

C–1. Explanation

a. Those ERC–A major equipment items that are key to a unit's capabilities as delineated in its authorization documents and central to a unit's ability to perform its doctrinal mission will be designated as pacing items; for example, a tank in a tank battalion. Because of the major importance of these pacing items to a unit they receive special emphasis in determining equipment C-ratings and are subject to continuous monitoring and management at all levels of command. This criteria will normally limit designation of pacing items in a unit to a range of 0–4, with the majority of units having two pacing items. The objective is to keep the number of designated pacing items to the lowest possible number consistent with the above guidance.

b. Not all organizations will have equipment designated as pacing items. Many units, such as a Light Infantry Rifle Company and a Personnel Services Company, are principally organized around personnel resources and not key items of equipment. Other organizations have such a wide variety of high cost, low density, ERC–A equipment that it is not appropriate to designate pacing items.

c. Regardless of whether or not a unit has designated pacing items, all units can identify equipment problems by calculating equipment C-ratings, using the remarks section of the report, and using subjective upgrade or downgrade as appropriate.

C–2. Unit pacing items

a. TOE units will report pacing items as designated in paragraph C–4, until such time as pacing items are identified on TOE/MTOE.

(1) TRADOC will use the guidance in paragraph C–1 and examples in table C–1 to determine unit pacing items. TRADOC will code pacing items in TOE with the code "P" in place of code "A" under the ERC column. This code will indicate that the item is both an ERC–A and a pacing item. Since TOE are not currently so coded, TRADOC will accomplish revised coding in conjunction with recommendation of the force to the "L" edition TOE (LTOE) format.

(2) Once TRADOC has initiated (1) above, MACOMs will code MTOEs using codes in TOEs. Units will disregard paragraph C–4 after pacing items have been designated in their MTOE. Use of a pacing item on a MTOE that is different from that on a TOE is not authorized without approval of HQDA(DAMO–ODR).

b. For an item listed in paragraph C–4 to be a pacing item for a specific unit, it must be required by the unit's MTOE. Exceptions to this are as follows:

(1) If a unit is short an equipment item designated as a pacing item for that type unit, but it has an authorized substitute (SB 700–20) or in-lieu-of item (para G–4), that item will be counted as a pacing item in place of the item the unit is short.

(2) A unit that receives a modernization item as a replacement for a current pacing item will consider the new item to be the pacing item even if it has not been added to table C–1 or coded with a "P" in the ERC column (for example, UH–60 helicopters replacing UH–1's or M1 tanks replacing M60 tanks). During transition, both old and new items may be counted if enough new items have not been received to meet the total authorization. However, old items must be on-hand in the unit and be in use. (They cannot be turned in to a direct support maintenance unit or otherwise out of the unit commander's control.)

c. TDA units will not report pacing items until such time as they are designated on their TDA.

C–3. Use of pacing items for preparing reports

a. Pacing items are limiting factors in determining EOH and ER C-ratings. EOH and ER ratings for battalion size and smaller units will be no higher than the lowest pacing item (PI) rating in EOH or ER respectively (C–4 being lower than C–1).

b. Equipment percentages and/or ratings for pacings items will be computed the same as for other reportable LINs (paras 3–7 and 3–8).

C–4. Pacing items of equipment

Table C–1 contains examples of pacing items of equipment for type units.

Table C–1
Pacing items of equipment

Type unit	Pacing item(s)
a. Armor:	
(1) Tank Co/Bn (less Abn).	Tank, Cbt, 105MM or 120MM
(2) Air Cav Trp/Sqdn (less Air Cav Trp, Armd (Cav Sqdn)—delete UH–1/60 for Recon Sqdn (LT).	AH–1, AH–64, OH–58, and UH–1/60.
(3) Armored Cav Trp/Sqdn (Armd Cav Trp—delete acft).	Tank Cbt, 105MM; CFV, M3/APC, M113; AH–1; and OH–58 (sqdn's assigned to Armd Cav Regt's—add 155MM SP Howitzer).
(4) Armor Bn (Abn).	M551 Sheridan until replaced.
b. Infantry:	
(1) Infantry Bn (all types except mech).	DRAGON and TOW launcher.
(2) Infantry Bn Mech.	IFV, M2/APC, M113; DRAGON; and ITV/M113 TOW.
(3) Antiarmor Co/TOW, Light Antitank Bn.	TOW launcher.
c. Combat aviation (acft intensive):	
(1) Attack Hel Bn/Co.	AH–1, AH–64, and OH–58.
(2) Air Cav Trp/Bn.	AH–1, AH–64, and OH–58.
(3) Cbt Avn Sqdn, ACR.	AH–1/AH–64, OH–58, UH–1, and UH–60.
d. Air defense:	
(1) Air Defense Artillery Bn, DUSTER.	DUSTER, M42.
(2) Air Defense Artillery Bn; Hawk, Square; Triad; or Assault Fire Unit (AFU).	HAWK systems and AN/TSQ–3.
(3) Air Defense Artillery Bn, CHAPARRAL/VULCAN.	CHAPARRAL and VULCAN (SP or Towed); and FAAR.
(4) Air Defense Artillery Bn, VULCAN Towed, Abn Div.	VULCAN and FAAR.
(5) Air Defense Artillery Bn, ROLAND.	ROLAND.
(6) Air Defense Artillery Bn, PATRIOT.	PATRIOT launcher and HHB ICC.
(7) Air Defense Artillery Bde, HHB.	AN/TSQ–73.
(8) Air Defense Artillery Bn, Signal.	AN/TRC–145 and AN/TRC–113.
e. Field artillery:	
(1) Field Artillery Bn, 105MM.	Howitzer, 105MM.
(2) Field Artillery Bn, 155MM (SP or Towed).	Howitzer, 155MM (SP or towed).
(3) Field Artillery Bn, 155MM Towed/8-inch SP.	Howitzer, 155MM, towed and Howitzer, 8-inch SP.
(4) Field Artillery Bn, 8-inch (SP or Towed).	Howitzer, 8-inch (SP or towed).
(5) Field Artillery Bn, LANCE.	LANCE.
(6) Field Artillery Bn, PERSHING.	PERSHING.
(7) Field Artillery Bn, 8-inch SP and MLRS.	Howitzer, 203 mm (8-inch SP) and launcher, MLRS.
(8) Field Artillery Btry, (Tgt Acq).	Radar; mortar locating and radar, artillery locating.
(9) MLRS Btry/Bn.	Launcher, MLRS.
(10) Signal Bn, FA Cmd, PERSHING.	Radio terminal set, AN/TRC–184; Repeater set radio, AN/TRC–115; Radio terminal set, AN/TRC–145; and Satellite communications, MSC–64.
f. Combat support aviation (acft intensive):	
(1) Army Aviation Co.	OH–58, UH–1/UH–60, and U–21/C–12.
(2) Aerial Exploitation Battalion (AEB).	OV–1, RV–1; and RC–12.
(3) EW Aviation Co, Forward.	RC–12D and RV–1.
(4) Aviation Battery Ambl Div.	OH–58.
(5) Combat Support Aviation Co/Bn.	UH–1 or UH–60.
(6) Command Airplane Co.	U–21/C–12.
(7) Corps Aviation Co.	OH–58 and UH–1/60.
(8) Division Aviation Co.	OH–58 and UH–1/60.
(9) General Support Avn Bn.	CH–47, OH–58, and UH–1/60.
(10) Heavy Helicopter Co.	CH–54.
(11) Helicopter Ambulance Det/Co.	UH–1/60.
(12) Medical Bn, Amb Div.	UH–1/60.
(13) Medium Helicopter Co/Bn.	CH–47.
(14) Assault Spt Hel Co.	CH–47.
(15) General Support Aviation Co.	UH–1, EH–1, and OH–58.
(16) Command Aviation Bn.	UH–1, UH–60, OH–58, and C–12/U–21.
g. Chemical:	
(1) Smoke Generator Co, mech.	Generator, smoke (mech).
(2) Smoke Generator Co, motor.	Generator, smoke; and truck, utility (HMMWV).
(3) Heavy Div Cml Co.	Generator, smoke (Mech) Decon apparatus (heavy); and truck, cargo 5 ton.
(4) NBC Defense Co/decontamination Co.	Decon apparatus (heavy); truck, cargo 5 ton.
(5) ACR Cml Co.	Generator, smoke; decon apparatus (Heavy); truck, cargo 5 ton; and truck, utility (HMMWV).
(6) Cml Co smoke/decon.	Generator, smoke decon apparatus (light); truck, utility (HMMWV).
h. Engineer:	
(1) Engineer Bn, Abn Div.	Tractor, full-tracked; truck dump 5 ton; truck, dump 2½ ton; and loader scoop, 2½ CY.
(2) Engineer Bn, Cbt, Corps.	Truck, tractor M916, semitrailer, Low bed 40 ton; tractor, full-tracked; and truck, dump 5 ton.
(3) Engineer Cbt Bn, Mech, Corps.	APC, M113; semitrailer, 40 ton; truck, tractor M916; and tractor, full-tracked.

Table C–1
Pacing items of equipment—Continued

Type unit	Pacing item(s)
(4) Engineer Co, ADM, Corps.	Tool Kit, spec weapons; radio set AN/PRC–77; radio set, control grp, AN/GRA–39; and truck, cargo 2½ ton.
(5) Engineer, light equip, abn.	Grader, road motorized; loader scoop, 2½ CY; tractor, full tracked; and truck, dump 5 ton.
(6) Engineer Co, MAB.	End bay, MAB; interior bay, MAB; transporter, MAB; and bridge erection boat, 27 FT.
(7) Engineer Co, medium Girder bridge.	Medium girder bridge assets (to install four 102 FT MLC 60 bridge or two 160 FT MLC 60 bridges) and truck dump, 5 ton.
(8) Engineer Co, panel bridge.	Panel (Bailey) bridge assets (to install two 80 FT double—single bridge or one 130 double—double bridge; to include launching nose) and truck dump, 5 ton.
(9) Engineer Co, float bridge.	Bridge erection boat, 27 FT; Class 60 components (for one float bridge 135 FT long or M4T6 components for 141 FT 8 IN float bridge); truck, stake 5 ton; and Compressor, 250 CFM.
(10) Engineer Co, aslt flt bridge, ribbon.	Bridge erection boat, 27 FT; Interior bay, float bridge; ramp bay, float bridge; and transporter, float bridge.
(11) Engineer Co, Sep Inf Bde, MAB.	End Bay, MAB; interior bay, MAB; and transporter, MAB.
(12) Engineer Co, ACR.	CEV; AVLB; APC, M113; and tractor, full-tracked.
(13) Engineer Co, Sep Armored Bde, MAB.	CEV, AVLB; APC, M113; and tractor, full-tracked.
(14) Engineer Port Construction Co.	Crane trk Mtd, 25 ton; crane, shovel 40 ton; tractor, full-tracked; and truck tractor, MET.
(15) Engineer Bn, ARMD/MECH Div.	APC, M113; AVLB; CEV; and loader scoop 2½ CY.
(16) Engineer Bn, Inf Div.	Truck, dump 5 ton; CEV loader scoop, 2½ CY; and AVLB.
(17) Engineer Co, Pipeline Construction.	Crane wheel mtd, 20 ton; tractor wheeled, IND; tractor, full-tracked and truck tractor, LET.
(18) Engineer Cbt Bn, Abn.	Loader scoop, 2½ CY; tractor, full-tracked; truck dump, 5 ton; and scraper, 11 CY.
(19) Engineer Bn, Aslt Div.	Loader scoop, 2½ CY; grader, road motorized; tractor, full-tracked; and truck dump, 2½ ton.
(20) Engineer Bn, TOPO.	Plate process section, TOPO repro set, semitrailer mounted; press section, TOPO repro set, semitrailer mounted; and camera section, TOPO repro set, semitrailer mounted.
(21) Engineer Co, Construction Spt.	Crane, shovel, 40 ton; loader, scoop 5CY, tractor, full-tracked; and truck, tractor, MET.
(22) Engineer Cmbt Bn, Heavy.	Scraper, 14–18 CY; loader scoop, 2½ CY; truck dump, 5 ton; and tractor, full-tracked.
i Medical:	
(1) Medical Bn, Support Command, Div.	Truck, ambulance.
(2) Medical Amb Co.	Truck, ambulance.
(3) Medical Supply, Optical and Maintenance.	Data processing system, automated, (DAS–3A, AN/MYQ–4).
(4) Medical Bn, Aslt Div.	UH–1/60.
(5) Medical Co, Air Amb.	UH–1/60.
(6) Medical Logistics Control Group.	Data processing system, automated, (DAS–3B, AN/MYQ–4A).
j. Maintenance:	
(1) Maint Bn, Divisional.	Recovery vehicle; and truck, wrecker, 5 ton.
(2) Maint Co.	Data processing system, automated, (DAS–3A, AN/MYQ–4).
(3) Aircraft Maint Co.	Data processing system, automated, (DAS–3A, AN/MYQ–4).
k. Ordnance:	
(1) Ordnance Co, RKT & MSL.	Data processing system, automated, (DAS–3B, AN/MYQ–4A).
(2) Ordnance Co, Ammo.	Trucks, fork lift, 6000 and 10,000 lb, rough terrain.
(3) Ordnance Co, Ammo, DS.	Fork lifts.
(4) Ordnance Co, Ammo, GS.	Container handler and fork lifts.
l. Quartermaster:	
(1) QM Co, POL.	Fuel system supply point.
(2) QM Co, Water Supply.	Water purification equipment and truck, tank, water.
m. Signal:	
(1) Signal Bn, Armor, Inf, or Mech Div.	AN/GRC–142 RDO TT set and AN/TRC–145 RDO TML set.
(2) Signal Bn, Abn or Aslt Div.	AN/TRC–145 RDO TML and AN/VSC–2 RDO TT.
(3) Corps Command Operations Bn.	AN/TSC–58 TML and AN/MGC–19 TT OPNS CTR or AN/TYC–39 auto msg switch.
(4) Corps Radio Bn.	AN/GRC–122 RDO TT set, AN/TRC–151 RDO TML set, and AN/TRC–152 RDO repeater set.
(5) Corps Area Signal Bn.	AN/TCC–73 TEL TML, AN/TRC–138 RDO repeater set, AN/TRC–151 RDO TML set, AN/TRC–152 RDO repeater set.
(6) Corps Command Operations Bn, (Abn).	AN/TSC–58 TML and AN/TRC–145.
(7) Signal Co, TROPO LT.	AN/TRC–112 and AN/TCC–60.
(8) Air Traffic Control Bn.	AN/TSQ 71B radar, AN/TSC–97 control tower, and AN/GRC–122.
(9) Corps Theater Support Command/Corps Theater ADP Service Center.	AN/MYQ–5

Table C–1
Pacing items of equipment—Continued

Type unit	Pacing item(s)
n. Supply and Transport:	
(1) S&T Bn, Armor, Inf, Mech Div.	Truck, cargo and truck, tractor, 5 ton. See note.
(2) S&S Bn, Abn or Amb Div.	Truck, Cargo. See note.
(3) Spt Bn/Sqdn, Sep Armor, Inf, Inf (Mech), Abn Bde, ACR.	Truck, cargo; truck tractor, 5 ton; and Data processing system, (DAS–3B, AN/MYQ4A). See note.
(4) Spt Bn, ACCB.	CH–47 and data processing system, automated, (DAS 3B, AN/MYQ–4A).
(5) S&S Co.	Truck, cargo; truck tractor, 5 ton; and data processing system automated, (DAS–3A, AN/MYQ–4). See note.
(6) MSB.	None.
(7) FSB.	None.
o. LG cmd, COSCOMs, DISCOMs, MMCs, data centers:	
(1) MMCs, Div.	Data processing system, automated, (DAS–3B, AN/MYQ–4A).
(2) MMCs, COSCOMs.	Data processing system, automated, (DAS–3A, AN/MYQ–4, and DAS–3B, AN/MYQ–4A).
(3) MMCs, TAAC.	Data processing system, automated, (DAS–3A, AN/MYQ–4A, and DAS–3B, AN/MYQ–4A).
(4) AG Co.	Data processing system, automated (DAS–3B, AN/MYQ–4A).
(5) HHC, Spt Gp.	Data processing system, automated, (DAS–3A, AN/MYQ–4).
p. Transportation:	
(1) TC Co, light truck or light-medium truck.	Truck, cargo 2½ ton and/or 5 ton (primary support vehicle) and truck, tractor 5 ton.
(2) TC Co, medium truck, cargo.	Truck, tractor, 5 ton; trailer, M871; trailer, M872; and truck, tractor M915.
(3) TC Co, medium truck, POL.	Truck, tractor, and semitrailer, tank bulk haul, and fuel servicing, 5000 gal.
(4) TC Co, heavy truck.	Truck, tractor HET.
(5) TC Co, medium lighter, LACV–30.	Air cushion vehicle (LACV–30).
(6) TC CO, medium boat.	Landing craft, medium.
(7) TC Co, heavy boat.	Landing craft, utility.
(8) TC Co, floating craft maint.	Data processing system, automated, (DAS–3A), AN/MYQ–4).
(9) TC Det, hvy amphibian.	Lighter, amphibian, 60T (LARC–LX).
(10) TC Co, terminal service.	Crane truck MTD 140 ton, crane truck MTD 20 ton, and truck, lift fork 50,000 LB.

Note:
Truck, Cargo; 2½ and/or 5 ton—whichever are the unit's primary mission support vehicle(s).

APPENDIX F

FIELD COMMENTS ON CODING ACTIVITY

F-1. COMMENT ORGANIZATION. TOE personnel at the schools had varying perspectives on the readiness coding process and the issues considered of importance. These comments fell into three categories. Some statements were of a general character, some dealt with specific equipment types and still others dealt with the coding consequences of linkages among equipments. The individual comments in each of these categories is provided in the following paragraphs. No particular order is used or is to be implied. Also, there was no attempt made to sort out any "apparent" inconsistencies in coding policy among TOE developers. For reference, each comment is preceded with an alpha code which identifies the school providing the comments.

F-2. GENERAL CODING COMMENTS

a. (AD) Two views were offered on the practice of working through unavailability of equipment. One position was that most systems can be operated with manual backup arrangements (for passage of orders). The other position was that the pace of the war will not allow time for ad hoc procedures and therefore all the allocated types of equipment are important in getting the job done.

b. (AD) It was recognized that it was important to be able to code the same LIN as either "A" or "B" as appropriate to its utilization and to have this distinction maintained as the LIN are rolled up into BN (or BTY) aggregations.

c. (AD) The "unit must stay alive" and this has implications for viewing some equipment in a personnel sense and not just a system sense.

d. (AD) There is no formal training for TOE developers, it is all OJT. The job description requires experience in the TOE branch speciality and civilian candidates are often selected from ex-military personnel. However, individuals with totally civilian backgrounds are recruited and the training can run from 1 to 2 years.

e. (AD) Local defense weapons are either permanently issued or held for issue by the HQ element, depending upon exposure of the unit.

f. (AR) The basis of issue plan (BIOP) considers a single piece of equipment, defines its function, and allocates the item of equipment across units in the Army. Of significance to the EXSYN study, the BOIP includes an ERC assignment. The ERC assignment, however, is not varied unit by unit within the BOIP, but simply assigned as a single value for all uses within the Army. There is the presumption that individual TOE developers will reexamine the assignment, and modify the code level, as appropriate.

g. (AR) Historically, the BOIP was prepared once and then passed into an archived state. With the "Living TOE" initiative, it will now be imperative that the BOIP be kept up to date, as a feeder into each increment of the Living TOE. These TOE, as submitted for HQ TRADOC and ARSTAF approval, must include a statement that the ERC assignments shown in the TOE conform to the assignment requirements of AR 220-1.

h. (AR) While the TOE is designed against requirements, there is an awareness of the availability of equipment in the field. This can translate into a reduction in ERC from "A" to "B", where no other pressing criteria for selection is present. This practice should be obviated by the "Living TOE", which will adjust unit requirements to the availability of equipment.

i. (AR) It was commented that tool kit ERCs should be assigned based on nature of use by personnel. If an individual needs a specific kit to do his job effectively, then the ERC should be "A", otherwise his skill is lost to the unit.

j. (AR) Conversely (to "i." above) item collections, such as tool kits, may be essential to the mission, but they are difficult to maintain intact. As such, they are sometime coded ERC 'B', to avoid readiness shortfalls, for want of missing items.

k. (AR) Within a TOE paragraph, i.e., element within a company, it is occasionally desirable to code the same piece of equipment (LIN) with a different usage. Such a coding distinction is not presently permitted by the TOE Planning System used to store the TOE documentation.

l. (EN) HQ units should be treated as a separate type of unit and rules developed to associate equipment with specific HQ users.

m. (EN) The comment that water trucks are essential because the troops need water, reflects one perspective on the concept of essential equipment. That is, the designated equipment does the essential job best. However, another perspective would hold that if the job can be done effectively, if less efficiently, by another equipment (say a truck with water cans) then the equipment is less essential. A third perspective would hold that equipment involving immediate troop support, and ultimately the effectiveness of the unit as a whole, should be a high priority.

n. (EN) Equipment densitiy (quantity issued) should be considered as a factor in ERC assignment, particularly in cases of a single item.

o. (TR) The transportation and supply units have a diversity of missions which cause elements of the unit to operate both in clusters and independently. This complicates the equipment relationships within the unit and the assignment of equipment readiness codes.

p. (TR) A useful distinction can be made between the mission as skill-based, supported by equipment, and equipment-based, supported by personnel (skills).

q. (IN) As noted in other school visits, there is a recognition by TOE developers of the logistic criticality of equipment. Some of the night vision devices are coded ERC "B" in anticipation that they can be made available as substitutes if ERC "A" devices are deadlined. Similarly, masks are coded "B" to reflect the practicalities of field losses and field damage and the readiness implications, if such equipment is unavailable when coded as ERC "A" equipment. Like masks, binoculars are coded ERC "B" to preclude readiness shortfalls due to field losses.

r. (IN) It was suggested that there may be value to considering use of a forward area dividing line to demark a change in the assessment of operations and the various shifts in equipment utilization which affect the assessment of equipment essentiality; for example, dividing lines for: communication mode (radio versus wire), need for protective equipment, and maintenance and supply services. However, there is also the prospect of enemy rear area operations which would argue for equipment assessment based on the worst case of operations.

s. (IN) The schools are also in the process of installing real-time links to the TRADOC Data Processing Field Office (DPFO) at Ft Leavenworth. At present the link exists, but it is batch-oriented, with an overnight response time. In the near future it will be possible to directly access the DPFO TOE data files and make needed TOE changes in real time. Looking to the future, it may be useful to consider having the expert system reside at the DPFO, rather than in the individual school micros.

t. (OD) Frequency of use may be a useful factor in assigning codes to equipments which are shared among equipments of varying essentiality.

u. (OD) It should be possible to identify essential equipment by having rules which test for its existence in the Division Element Annex of the Division Organization and Operation Plan. Additional rules will be necessary to account for other essential equipment which may have to be added after the Plan was completed, as part of the TOE development.

v. (QM) In the combat area, the supply concept is to keep "uploaded" (storage on trucks) all the time. Generators have sufficient fuel capacity to run between scheduled resupply. However, line haul tankers do not have fuel dispensing equipment.

w. (QM) Army units in combat are now fed in field feeding clusters to reduce the number of cooks. Specific units are designated "feeders" and have kitchen equipment to fulfill this mission.

x. (QM) Emphasis is placed on cellular (independent) operation of supply units to permit flexible operation.

y. (QM) Depending on mission, unit operations may be dispersed or collocated. This can limit the opportunity to share equipment.

z. (QM) Position on battlefield (division, corps, echelons above corps) affects extent of unit element collocation, communication, and security equipment needs.

F-2. EQUIPMENT-SPECIFIC CODING COMMENTS

a. (AD) For air defense units, individual weapons and face masks are coded ERC "A". The rationale is that these units tend to operate automomously, often in forward areas, and such protection is essential to the conduct of the mission.

b. (AD) The unit commander and each of his primary staff need a radio and transportation (usually a light truck and often a trailer for field gear and camouflage netting).

c. (AD) Radios are used for mobile operation, with wire for backup.

d. (AD) Generators are always ERC "A". They either are dedicated to systems or distribute power to run vehicle radios when the vehicle engines are off.

e. (AD) Radio antennas are used either for normal operation or added to gain additional range.

f. (AD) Wrist watches, which are universally assigned ERC "C" by AR 220-1, may, in fact, be used to time operations and should be assigned a higher code.

g. (AD) Binoculars, similar to wristwatches, may have either a supportive or essential role. Short-range air defense weapons system teams, for example, will use binoculars to positively identify aircraft targets passed by the forward area alerting radars and should be assigned a higher code.

h. (AR) Mess equipment is coded as ERC "B" in spite of the unit mission to provide feeding to other local units under the new combat field feeding system. The rationale is that field rations are available, and the feeding equipment used for hot meals is not essential. However, it represents a case where equipment, issued in direct support of a mission requirement, is not considered ERC "A".

i. (AR) "Installation kits" are used to install radios in wheeled vehicles, as needed. All tracked vehicles have radios, so installation kits are factory installed. However, there are variations among radios, and "accessory kits" are provided to custom install radios into tracked vehicles. These "accessory kits" are coded with the same ERC as the tracked vehicle, namely ERC "A".

j. (AR) Mine detectors (in the HQ element) are coded ERC "B" because they are useful, but not essential, to the headquarters mission.

k. (AR) Recovery vehicles, in armor units, are ERC "B" by regulation, but should be ERC "A" in terms of essentiality.

l. (AR) Armor vehicles have mounted machineguns, which may be dismounted and used with separate mounts. These separate mounts are ERC "B" in armor units, since armor units do not have a mission to fight dismounted. The same mount, however, is ERC "A" in infantry units, which have mission to fight dismounted.

m. (AR) Not all trucks in armor units are ERC "A". The distinction is whether they are used for "combat" or "relocation" moves. Truck trailers have the same ERC as their prime movers.

n. (FA) All communications equipment is ERC "A".

o. (FA) All trucks in FA units are ERC "A". If not otherwise "A", they can all be used to carry ammo. Truck trailers may be "A" or "B", depending on their use and ability to haul ammo.

p. (FA) All individual weapons are ERC "A", all masks are "B", heavy machine guns (50 cal) are "A", light machine guns (7.62mm) are "B", computers are "A".

q. (FA) At the direction of the Vice Chief of Staff Army, there was a "generator scrub" to reduce the number of generators. This was accomplished by consolidating tent light sets on fewer generators, by colocating the tent users, if necessary. The ERC of the generator is based on the most critical user on the line.

r. (IN) Factors affecting radio equipment utilization and consequent equipment essentiality were identified as follows. Radio is normally used for mounted infantry, where mobility is desired. However, use of an auxiliary antenna, for extended range operation, is not normally feasible. Foot mobile units, on the other hand, are concerned with local area operations and may use wire as a principal communication mode. Patrols use radio, while base activities use wire. Over-the-road trucks, per AR 310-34, do not have radios (convoy lead vehicle has radio).

s. (IN) Decontamination equipment basically provides a shower capability and is coded ERC "B". It is also used as a field shower.

t. (IN) Mortar fire is sighted using a compass (ERC "A") procedure, rather than the more accurate, but complicated, aiming circle (ERC "B") procedure.

u. (IN) In one TOE situation, the document reproduction equipment is coded ERC "B", since there is a mission requirement to disseminate orders. In another TOE the reproduction equipment is coded ERC "C", since there is no specific mission, only an increase in the efficiency and convenience of document distribution.

v. (QM) Supply unit weapons are coded as ERC "B".

w. (QM) Hand-held radios are used to coordinate dispersed supply point operations.

F-3. EQUIPMENT LINKAGE CODING COMMENTS

a. (AD) It was generally agreed that the generator powering a system should have the same ERC as the equipment powered. It was less clear whether the tanker truck, that regularly resupplies the generator, should also have the same ERC.

b. (AR) The basic ammo load is determined from combat factors compiled in the Command and General Staff College document, Combat Factors, CGSC 101-2, which is an undated version of FM 101-10-1. To the extent that the basic load exceeds the carrying capacity of the tank, it is carried in an accompanying truck which, in effect, becomes an extension of the tank. The truck is coded with the same ERC as the tank, namely "A".

c. (AR) Radios come with a basic antenna and may be provided with an additional antenna to extend the range, this latter antenna is ERC "B". Multiplexers are provided for radios so that they may share a single antenna, thereby reducing the number of sources of emitted signals. In this instance, the multiplexer is coded ERC "A".

d. (TR) Consideration of the value of the load carried was indicated as a factor in assessing a higher code level to a radio on a transporter. A radio on a Heavy Equipment Transporter, which carries a tank, would be coded higher than a radio equipment on a basic transport vehicle.

e. (IN) Trucks are ERC "A", since all trucks can serve as replacements for those trucks which are ERC "A".

f. (IN) The training set for the TOW, which would normally be ERC "C", is coded ERC "B", since it also has a maintenance use.

g. (OD) In clean working environments, single purpose testers/tools may be used to replace special testers/tool sets, whereas in the dirty working environment, special test/tool sets are preferable.

h. (QM) By policy, aircraft fuel (JP4) is filtered each time it is transferred.

APPENDIX G

VALIDATION PLAN

INTRODUCTION. The validation plan shown in this appendix is a facsimile of the plan originally developed to evaluate the performance of the prototype system. Its use, however, was limited by the problems with machine and system performance discussed in Chapter 5. The plan is included as a reference for what was intended in the way of the prototype evaluation, and what should be considered in any future evaluation of the system. The plan is modeled on, and closely follows, the organization and editorial style for the Test Plan in DOD 7935.1-STD, Automation Data Systems Documentation Standards. Departures from the Test Plan standard have been made, as necessary, to meet the specialized testing needs of expert systems not provided for in the Standards.

SECTION 1. GENERAL

1.1 Purpose of the Validation* Plan.

This Validation Plan for the Equipment Readiness Code Advisor (ADVISOR) prototype system is written to:

a. Provide guidance for the management of the effort necessary for prototype system validation.

b. Establish the nature and extent of the validation necessary to establish the utility of the prototype system, as the basis for development of a full-scale, deliverable system.

c. Coordinate with the field activities involved in the prototype validation.

d. Establish the procedure for the conduct of the prototype validation.

e. Provide a baseline methodology for development of a validation plan for the production system.

1.2 Project References.

a. AR 220-1, Unit Status Reporting, 16 Sep 86.

b. TRADOC Regulation 310-4, Living Tables of Organization and Equipment.

1.3 Terms and Abbreviations. See Glossary.

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*The system under evaluation uses expert system technology (search based processing) which does not lend itself to the systematic testing associated with numeric (algorithm based) systems. Instead, a series of examples is used to establish the satisfactory functioning of the system. This example-based process of system test is referred to as validation.

SECTION 2. VALIDATION PLAN

2.1 System Description.

a. The ADVISOR is an automated tool for use by combat developers for the assignment of equipment readiness codes (ERC) to unit equipment in accordance with AR 220-1. The ADVISOR consists of an expert system with two associated knowledge bases containing the rules for making ERC assignments and associated routines and files for controlling the overall operation, storage and display of summary results.

b. In the course of operation, the ADVISOR uses first one knowledge base, then the other. The first knowledge base contains the rules for processing unit "core" equipment, that is, equipment essential to the performance of the unit mission. The ADVISOR always identifies some unit equipment as "core." In addition, the ADVISOR may identify some of this core equipment as "pacing" equipment (within the meaning of AR 220-1). The second knowledge base contains the rules for processing the remaining "noncore" equipment in the unit.

c. The system operates interactively with the user. The user provides the information which allows the ADVISOR to search its knowledge base for the appropriate ERC assignment rule and display the result.

2.2 Validation Objective. The objective of the validation is to establish that the prototype for the ADVISOR system produces appropriate ERC assignments when used by combat developers experienced with the TOE whose equipments are to be coded. Appropriate shall mean in accordance with the controlling regulation (AR 220-1) and the prevailing practice of the developers, as judged by a Validation Panel. The panel, to be convened for this purpose, is described in 2.6.

2.3 Validation Scope. The validation will address three different types of TOE organizations considered representative of the heavy division (company-size) units focused on in the prototype development. The three unit types are: field artillery, aviation logistics, and headquarters units. Three TOE have been selected for each TOE type. The TOE have been arranged into three TOE sets (Set I, Set II, Set III) for validation purposes, as shown in Table 2-1.

Table 2-1. TOE for Use in Validation

TOE set	Unit type	TOE	Name
I	HHC	87004J4	HHC Armd Div
I	FA	06367J4	FA Btry
I	TC/Avn Log	55427J4	Trans Acft Maint Co
II	HHC	17236J4	HHC Tk Bn
II	FA	06369J4	Service Btry
II	TC/Avn Log	55087J4	Trans Motor Trans Co
III	HHC	TBD*	
III	FA	TBD*	
III	TC/Avn Log	TBD*	

*To be determined--selected from TOE currently under development.

2.4 Validation Site. The validation of the ADVISOR will be conducted at TRADOC HQ, Ft Monroe, VA.

2.5 Validation Schedule. The validation schedule provides for a start-up activity, (3) cycles of use of the ADVISOR, and a wrap-up activity. The entire sequence of activity is conducted over a period of 5 days, as shown in Table 2-2.

Table 2-2. Validation Schedule

Day	Period	Activity (cycle)	See para. (Chapter 3)
1	AM	TOE Item Selection	3.2.1.a
	PM	ADVISOR Orientation	3.2.1.b
2	AM	ADVISOR Use (I)	3.2.2.a
	AM	ADVISOR Review (I)	3.2.2.b
	PM	ADVISOR Update (I)	3.2.2.c
	PM	TOE Update (I)	3.2.2.d
3	AM	ADVISOR Use (II)	3.2.2.a
	AM	ADVISOR Review (II)	3.2.2.b
	PM	ADVISOR Update (II)	3.2.2.c
	PM	TOE Update (II)	3.2.2.d
4	AM	ADVISOR Use (III)	3.2.2.a
	AM	ADVISOR Review (III)	3.2.2.b
	PM	ADVISOR Assessment	3.2.3.a

2.6 Site Requirements.

2.6.1 Site Equipment. The on-site equipment required for the validation is as follows:

Quantity	Item
3	Personal computer, with 256K memory (min)
3	Printer, 80 col (min)
3	Workspace for TOE printouts

2.6.2 Site Software. The on-site software required for the validation follows. The system developer will provide the expert system packages.

Quantity	Item
3	PC-DOS Operating System, 2.1 or higher (or MS-DOS equivalent)
3	Expert System, runtime package
1	Expert System, developer package

2.6.3 Site Material. The material required for the validation consists of one copy of each TOE identified in Table 2-1.

2.6.4 Participating Personnel. The personnel required for the validation are as follows:

Number	Skill	Period needed	Percent time needed
3	TOE Developer	Day 1-4	50
1	HQ TOE Reviewer	Day 1-5	75
1	HQ TOE Manager	Day 1-5	25

2.7 Validation Panel. The Validation Panel shall be constituted on-site, at the start of the activity, and serve throughout the evaluation. The Panel shall conduct the scheduled ADVISOR Reviews and Validation Assessment. The Panel membership shall consist of the Participating Personnel (2.6.4) and shall be chaired by the HQ TOE Manager.

SECTION 3. VALIDATION PROCEDURE

3.1 Functions Validated. The ADVISOR functions by assigning an equipment readiness code (ERC) to an item of unit equipment based on user-provided information. Two modes of operation are involved, a Core Equipment Mode and Noncore Equipment Mode.

a. Core Equipment Mode. In this mode, the user indicates the unit mission. The ADVISOR responds with the identification of the core items of equipment associated with the mission and the ERC for each core equipment. The ERC assignment differentiates between a designation of ERC-A (essential) and ERC-P (pacing).

b. Support Equipment Mode. In this mode, the user indicates the use of an item of equipment within the unit. The ADVISOR responds with the category of use of the equipment and the ERC assigned (ERC-A, ERC-B, or ERC-C).

3.2 Validation Progression. The validation progression provides for a start-up activity, three cycles of use of the ADVISOR, and a wrap-up activity. The entire sequence of activity is conducted over a period of 5 days following the schedule shown in Table 2-2. Each activity is described in the following paragraphs.

3.2.1 Initial Activities

a. TOE Item Selection. The validation will be carried out using the three sets of TOE shown earlier in Chapter 2 (Table 2-1). A sampling process is used to select individual items of equipment in each TOE for assessment by the ADVISOR. This process will be carried out on DAY 1 by the TRADOC HQ personnel participating in the validation. The selection of equipment to be used will be marked on the TOE copies provided as site materials. These marked-up copies will serve as the TOE reference by the ADVISOR users. For those TOE already reviewed and approved, the selection will make use of the existing coding as a guide to the selection. For those TOE not yet approved, an estimate of the final coding will provide a basis for selection. The criteria for selection of the equipment are as follows.

- All ERC-P/ERC-A coded equipment in TOE, or all TOE equipment considered ERC-P/ERC-A.
- All ERC-C equipment in TOE, or all TOE equipment considered ERC-C

- Approximately 25 percent of the equipment coded ERC-B in each TOE, selected by choosing every fourth ERC-B item as it appears in the paragraph level of the TOE. If this process generates more than 50 items for evaluation, a reduced percentage factor will be used to achieve the 50-item limit.

Departure from these criteria may be made to examine special cases of equipment usage in particular units.

b. ADVISOR Orientation. The orientation to the ERC ADVISOR will address the following subjects over a 3-hour period.

Subject	Time
Expert System Concept	45 min
ADVISOR Knowledge Bases Break	45 min
ADVISOR Displays	15 min
Input of User Reaction	30 min
Trial Runs (three workstations)	30 min

3.2.2 Cycles of System Use. The validation will be carried out by exercising the ADVISOR on one set of TOE at a time, thereby completing one validation cycle before another begins. Each cycle will be a self-contained validation. The TOE items will be coded, the results evaluated by the Validation Panel, updates, as necessary, made to the ADVISOR knowledge base (rules), and updates, as necessary, made to the TOE sets. The activities of a cycle are as follows:

a. ADVISOR Use. The three ADVISOR workstations will be used concurrently, and monitored by the Developer and TRADOC HQ representatives. The TOE developer user at each workstation will be assigned TOE associated with their respective backgrounds.

Step 1 - Core Equipment Processing. Working from the TOE listing, the user will respond to the prompts provided by the ADVISOR for unit identification information. This will be followed by prompts for unit mission information. In response to these queries, the ADVISOR will display the core equipment of the unit (always present) coded ERC-A and pacing items of the unit (when present) coded ERC-P.

Step 2 - Support Equipment Processing. Again working from the TOE listing, the user will select the next item of equipment, indicated in the listing, for evaluation. The user will then respond to prompts from the ADVISOR for information about the use of the equipment within the unit. In response to these queries, the ADVISOR will display the ERC of the item and prompt the user for a comment on the just completed

coding activity. This will be done by prompting the user for a reaction after each item has been processed and by storing this information automatically as part of the ERC results recorded by the system. The user will be prompted twice, once for the rule used by the system to assign the ERC, and a second time for a comment on the validity of the assigned level of ERC, based on the user's expectations.

The user is requested to enter the number of the rule used to arrive at the assignment. The rule number is shown in the upper left corner of the Rule Statement. This number must be noted at the time the rule is displayed. It is input to the ADVISOR in response to the prompt for the Rule number which accompanies the prompt for the user comment.

Standardized user comments to indicate their reaction to the code assigned by the ADVISOR are shown in Table A-1. The comment is input to the ADVISOR by comment number, in response to the system prompt after the ERC assignment is completed. The user enters the selected comment. The user is then asked if another item is to be evaluated. After each item and its associated comment is processed, the prompt for a further item is repeated. When the last item is reached, the user requests a printout of the overall ERC results for subsequent review.

b. ADVISOR Review. The results of the ADVISOR Use session will be reviewed by the Validation Panel. The Panel will determine the changes to be made on-site and those issues to be considered outstanding.

(1) Review Criteria. The ERC ADVISOR results will be reviewed using the following criteria.

- Conformance to AR 220-1. The extent to which the ADVISOR generates ERC which agree with coding in the approved TOE. The extent will be measured as a percent of the evaluated items correctly coded using the system.

- Deviation from AR 220-1. The extent to which the ADVISOR generates ERC which deviate from the coding in the approved TOE.

- Interpretation of AR 220-1. The extent to which the ADVISOR generates ERC which reasonably interpret the guidance given in AR 220-1. This criterion will be applied in those cases where the TOE have not been approved, and in those cases of deviation from the AR where an alternative coding rationale is considered to have merit.

(2) Review Process. The review process will include the following.

- ADVISOR printouts will be examined by the Validation Review Committee.
- Assessment criteria will be applied and a list of rule updates generated.
- An Outstanding Issues List will be generated to record items for further consideration.

c. ADVISOR Update. Where the Panel finds that the ADVISOR knowledge base could be changed to correct an error or more accurately represent conditions affecting the ERC assignment, such changes will be made on-site by the Developer prior to the next day's activity. A record of all such changes will be marked into a copy of the User's Manual maintained for this purpose by the developer. No ADVISOR Update is included in the last cycle of use.

Table A-1. User Reaction Codes

Section	Standardized Comments
SECTION I.	Consider Selection Among Choices Provided: 1 - Selections clear and choices readily related to equipment 2 - Selections clear, but choice needed was not present 3 - Rule questionable, significant factors missing
SECTION II.	Consider Rule Used to Assign ERC: 1 - Rule satisfactory, appropriate factors present 2 - Rule unsatisfactory, inappropriate factors present 3 - Rule questionable, significant factors missing
SECTION III.	Consider ERC Assigned to Equipment: 1 - ERC conforms to AR 220-1 2 - ERC reasonably interprets AR 220-1 3 - ERC deviates from AR 220-1
SECTION IV.	Enter any text comment desired (30 char max)

d. TOE Update. Where the Panel finds that the evaluation process could be enhanced by adjustments to the selection of the TOE items being used, such changes will be made. No TOE Update is included in the last cycle of use.

3.2.3 Concluding Activity

a. ADVISOR Assessment. The experience of the ADVISOR Use and ADVISOR Review sessions and the Outstanding Issues List will provide a basis for a summary assessment of the validation activity. The assessment will include:

- Detailed examination of the outstanding issues.
- Determination of the final outstanding issues.
- Categorization and documentation of the final issues into an assessment product.

b. Assessment Product. The results of the validation activity will be summarized in a letter report, directed to the study sponsor (DAMO-ODR). The report shall be prepared by the chair of the Validation Panel, coordinated with the developer, and incorporate the following:

- Statement of Issues for TRADOC HQ consideration based on an inability to formulate rules, due to lack of policy or inconsistencies in current policy.
- Statement of Issues for ARSTAF consideration based on an inability to formulate rules, due to a conflict with AR 220-1 guidance which seems inappropriate for circumstances.
- Statement of Issues for Developer consideration based on inability of system to perform in a manner considered desirable by users, apart from consideration of the coding rule issues covered above.
- Statement of the experience with the ADVISOR and its potential for effectiveness as a TOE development tool.

GLOSSARY

ADVISOR	short form of Equipment Readiness Code Advisor
AR	Army regulation
core equipment	equipment essential to the performance of the unit mission
support	equipment in unit other than the core equipment
ERC	equipment readiness code, a three-level code (A (highest), B, or C) which is assigned to an equipment in a unit, to indicate its importance to the conduct of the unit mission. Within the A-level especially critical items are disigned are pacing items or ERC-P.
ERC-P	equipment of the highest essentiality to a unit as defined in AR 220-1
expert system	a computer program that uses knowledge and logical inference procedures to solve problems that normally require human expertise for their solution
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
TOE	table(s) of organization and equipment
TRADOC HQ	Training and Doctrine Command Headquarters
validation	process of demonstrating that an expert system produces useful results

APPENDIX H

CORE EQUIPMENT RULES

H-1. INTRODUCTION. This appendix catalogs all the rules in the expert system which identify the core items of equipment in a unit and distinguish whether these equipments are "core" equipment, with an ERC-level of "A", or the more critical "pacing items" of equipment, with an ERC-level of "P". The rules are provided for general reference.

a. Only a limited number of unit types (representative of those in a heavy division) were considered in developing these rules. However, a sufficient variety of types is present to demonstrate that meaningful descriptors of unit activity, in terms of unit mission and unit mission-task, can be identified for purposes of rule construction. The catalog is open-ended, in that as new missions or mission-tasks are generated by the force development process, new rules will have to be added.

b. Associated with each rule is a rule number assigned by the system. It is used during development and maintenance of the system, to identify the rule for editing purposes. The rule number, or more precisely, the rule order in the system, which the rule number indicates, has significance in the system operation. The rule sequence affects the order of rule search and, in turn, the efficiency of the search. The rule number has no particular significance to the system user, except as a convenient way of identifying the rule for discussion or documentation purposes.

c. As described in Chapter 4, each rule is constructed using standardized text grouped into an IF-Part and a THEN-Part. The IF-Part contains one or more statements which, if all are true, means that all the statements contained in the THEN-Part are true. For the rules in this appendix, the IF-Part of each rule defines a particular combination of mission and mission task. The THEN-Part of the rule identifies the equipment essential to accomplishing this combination of mission and mission-task.

H-2. INDIVIDUAL CORE EQUIPMENT RULES. The individual rules, as shown in the following pages, reflect the order of the rules in the present system. They were produced, via printout from the system, using an option available in the editing process.

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RULE NUMBER: 1

IF:
        THE UNIT PROPONENT IS AIR DEFENSE ARTILLERY
  and   THE AIR DEFENSE UNIT MISSION IS ENGAGE ENEMY AIRCRAFT
  and   THE AIR DEFENSE MISSION-TASK IS FORWARD AIR DEFENSE AGAINST LOW LEVEL
        SORTIES


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   AD CORE EQUIP:  MAN PORTABLE AD MSL, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-AD01  (VER 2.0)


REFERENCE:
  TOE 44-167J4, ADA BTY, ADA BN  (TAB 8)
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RULE NUMBER: 2

IF:
        THE UNIT PROPONENT IS ARMOR
  and   THE ARMOR UNIT MISSION IS ENGAGE ENEMY MANUEVER UNITS
  and   THE ARMOR MISSION-TASK IS CONDUCT TANK ASSUALT USING MIXED CALIBER
        FIRES


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   AR CORE EQUIP:  TANK, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-AR01  (VER 2.0)


REFERENCE:
  TOE 17-237J4, TNK CO, TNK BN  (TAB 18)
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RULE NUMBER: 3

IF:
        THE UNIT PROPONENT IS ARMOR
  and   THE ARMOR UNIT MISSION IS RECONNOITER ENEMY
  and   THE ARMOR MISSION-TASK IS GROUND SEARCH OF DESIGNATED AREA


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   AR CORE EQUIP:  CAV FIGHTING VEHICLE, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-AR02  (VER 2.0)


REFERENCE:
  TOE 17-207J4, CAV TRP, CAV SQDN  (TAB 34)
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RULE NUMBER: 4

IF:
        THE UNIT PROPONENT IS ARMOR
  and   THE ARMOR UNIT MISSION IS RECONNOITER ENEMY
  and   THE ARMOR MISSION-TASK IS AIRBORNE SEARCH OF DESIGNATED AREA


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   AR CORE EQUIP:  OBSN HEL, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-AR03


REFERENCE:
  TOE 17-208J4, AIR CAV TRP, CAV SQDN  (TAB 35)
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RULE NUMBER: 5

IF:
        THE UNIT PROPONENT IS AVIATION
  and   THE AVIATION UINT MISSION IS ENGAGE ENEMY ELEMENTS
  and   THE AVIATION MISSION-TASK IS AIRBRONE ATTACK WITH MIXED ORDINANCE FIRES


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   AV CORE EQUIP:  ATTACK HEL, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-AV01  (VER 2.0)


REFERENCE:
  TOE 01-387J4, ATK HEL CO, AVN BN  (TAB 37)
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RULE NUMBER: 6

IF:
        THE UNIT PROPONENT IS ENGINEEER
  and   THE ENGINEER UNIT MISSION IS INCREASE DIVISION EFFECTIVENESS
  and   THE ENGINEER MISSION-TASK IS EARTHWORK AND ROADWORK CONSTRUCTION


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   EN CORE EQUIP:  SCOOPER-LOADER, ERC-P
  and   EN CORE EQUIP:  SCRAPER, ERC-P
  and   EN CORE EQUIP:  DUMP TRUCK, ERC-P
  and   EN CORE EQUIP:  TRACTOR, ERC=P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-EN01  (VER 2.0)


REFERENCE:
  TOE 05-147J4, ENG CO, ENG BN  (TAB 10)
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RULE NUMBER: 7

IF:
        THE UNIT PROPONENT IS ENGINEEER
  and   THE ENGINEER UNIT MISSION IS INCREASE DIVISION EFFECTIVENESS
  and   THE ENGINEER MISSION-TASK IS EMPLACE ASSUALT BRIDGING


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   EN CORE EQUIP:  ASLT BRIDGE LAUNCHER, ERC-P
  and   EN CORE EQUIP:  ASLT BRIDGE SECTIONS, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-EN02  (VER 2.0)


REFERENCE:
  TOE 05-147J4, ENG CO, ENG BN  (TAB 10)
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RULE NUMBER: 8

IF:
        THE UNIT PROPONENT IS ENGINEEER
  and   THE ENGINEER UNIT MISSION IS INCREASE DIVISION EFFECTIVENESS
  and   THE ENGINEER MISSION-TASK IS PREPARE BATTLE POSITIONS


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   EN CORE EQUIP:  ARMORED COMBAT EARTHMOVER, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-EN03  (VER 2.0)


REFERENCE:
  TOE 05-147J4, ENG CO, ENG BN  (TAB 10)
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RULE NUMBER: 9

IF:
        THE UNIT PROPONENT IS ENGINEEER
  and   THE ENGINEER UNIT MISSION IS INCREASE DIVISION EFFECTIVENESS
  and   THE ENGINEER MISSION-TASK IS UNIT MAINTENANCE


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   EN CORE EQUIP:  RECOVERY VEHICLE, ERC-P
  and   EN CORE EQUIP:  WRECKER, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-EN04  (VER 2.0)


REFERENCE:
  TOE 05-147J4, ENG CO, ENG BN  (TAB 10)
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RULE NUMBER: 10

IF:
        THE UNIT PROPONENT IS ENGINEEER
  and   THE ENGINEER UNIT MISSION IS EMPLACE WATER GAP CROSSINGS
  and   THE ENGINEER MISSION-TASK IS EMPLACE GAP CROSSING SYSTEM


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   EN CORE EQUIP:  GAP CROSSING SYS, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-EN05  (VER 2.0)


REFERENCE:
  TOE 05-148J4, BRIDGING CO, ENG BN  (TAB 11)
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RULE NUMBER: 11

IF:
       THE UNIT PROPONENT IS ENGINEEER
  and  THE ENGINEER UNIT MISSION IS UNIT MAINTENANCE
  and  THE ENGINEER MISSION-TASK IS THROUGHPUT OF REPAIRABLES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  EN CORE EQUIP:  CONTACT VEHICLE, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-EN06  (VER 2.0)


REFERENCE:
  TOE 05-148J4, BRIDGING CO, ENG BN  (TAB 11)
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RULE NUMBER: 12

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS ENGAGE ENEMY WITH INDIRECT FIRES
  and  THE FIELD ARTILLERY MISSION-TASK IS CONDUCT INDIRECT HEAVY CALIBER
       FIRES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  HEAVY CALIBER CANNON, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA01  (VER 2.0)


REFERENCE:
  TOE 06-367J4, FA BTY, 155SP, DIV ARTY  (TAB 27)
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RULE NUMBER: 13

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS ENGAGE ENEMY WITH INDIRECT FIRES
  and  THE FIELD ARTILLERY MISSION-TASK IS CONDUCT MASSED ROCKET FIRES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  MULTIPLE RKT LAUNCHER SYS, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA02  (VER 2.0)


REFERENCE:
  TOE 06-368J4, FA BTY, MLRS, DIV ARTY CO  (TAB 25)
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RULE NUMBER: 14

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS LOCATE ENEMY FOR ENGAGEMENT
  and  THE FIELD ARTILLERY MISSION-TASK IS LOCATE ENEMY MOVEMENT


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  MOVING TGT LOC RADAR, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA03  (VER 2.0)


REFERENCE:
  TOE 06-307J4, TGT ACQ CO, DIV ARTY  (TAB 24)
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RULE NUMBER: 15

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS LOCATE ENEMY FOR ENGAGEMENT
  and  THE FIELD ARTILLERY MISSION-TASK IS LOCATE ENEMY ARTILLERY


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  ARTY LOC RADAR, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA04  (VER 2.0)


REFERENCE:
  TOE 06-307J4, TGT ACQ CO, DIV ARTY  (TAB 24)
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RULE NUMBER: 16

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS LOCATE ENEMY FOR ENGAGEMENT
  and  THE FIELD ARTILLERY MISSION-TASK IS LOCATE ENEMY MORTARS


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  MORTAR LOC RADAR, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA05  (VER 2.0)


REFERENCE:
  TOE 06-307J4, TGT ACQ CO, DIV ARTY  (TAB 24)
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RULE NUMBER: 17

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS SERVICE FA BN
  and  THE FIELD ARTILLERY MISSION-TASK IS SUPPLY CLASS I, II, III, VII ITEMS


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  TANK TRUCK, ERC-A
  and  FA CORE EQUIP:  TANK & PUMP UNIT, ERC-A
  and  FA CORE EQUIP:  TANK UNIT, ERC-A
  and  FA CORE EQUIP:  CARGO TRUCK, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA06  (VER 2.0)


REFERENCE:
  TOE 06-369J4, SERVICE BTY, FA BN  (TAB 28)



RULE NUMBER: 18

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS SERVICE FA BN
  and  THE FIELD ARTILLERY MISSION-TASK IS PROVIDE AMMUNITION TRANSFER POINT


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  CARGO TRUCK WITH CRANE, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA07  (VER 2.0)


REFERENCE:
  TOE 06-369J4, SERVICE BTY, FA BN  (TAB 28)
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RULE NUMBER: 19

IF:
       THE UNIT PROPONENT IS FIELD ARTILLERY
  and  THE FIELD ARTILLERY UNIT MISSION IS SERVICE FA BN
  and  THE FIELD ARTILLERY MISSION-TASK IS AUTOMOTIVE MAINTENANCE SUPPORT


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  FA CORE EQUIP:  EQUIP SPECIFIC TEST SET, ERC-A
  and  FA CORE EQUIP:  EQUIP SPECIFIC TOOL SET, ERC-A
  and  FA CORE EQUIP:  PARTS STORAGE VAN, ERC-A
  and  FA CORE EQUIP:  CONTACT VEHICLE, ERC-A
  and  FA CORE EQUIP:  RECOVERY VEHICLE, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-FA08  (VER 2.0)


REFERENCE:
  TOE 06-369J4, SERVICE BTY, FA BN  (TAB 28)



RULE NUMBER: 20

IF:
       THE UNIT PROPONENT IS LOGISTICS CENTER
  and  THE UNIT MISSION IS PROVIDE COMMAND, CONTROL AND SUPERVISION OF BN
       OPERATIONS
  and  THE HEADQUARTERS MISSION-TASK IS CONDUCT TACTICAL OPERATIONS


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  HQ CORE EQUIP:  COMMANDER VEHICLE, ERC-A
  and  HQ CORE EQUIP:  SECTION CHIEF VEHICLE, ERC-A
  and  HQ CORE EQUIP:  COMMAND NET RADIO, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-HQ01  (VER 2.0)


REFERENCE:
  TOE 07-246J4, HQ CO, INF BN  (TAB 20)
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RULE NUMBER: 21

IF:
        THE UNIT PROPONENT IS LOGISTICS CENTER
  and   THE UNIT MISSION IS PROVIDE COMMAND, CONTROL AND SUPERVISION OF BN
        OPERATIONS
  and   THE HEADQUARTERS MISSION-TASK IS CONDUCT SUPPORT OPERATIONS


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   HQ CORE EQUIP:  COMMANDER VEHICLE, ERC-A
  and   HQ CORE EQUIP:  SECTION CHIEF VEHICLE, ERC-A
  and   HQ CORE EQUIP:  ADMIN-LOG NET RADIO, ERC-A
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-HQ02  (VER 2.0)


REFERENCE:
  TOE 07-246J4, HQ CO, INF BN  (TAB 20)



RULE NUMBER: 22

IF:
        THE UNIT PROPONENT IS LOGISTICS CENTER
  and   THE UNIT MISSION IS PROVIDE SUPERVISION OF OPERATIONS
  and   THE HEADQUARTERS MISSION-TASK IS CONDUCT CO SUPPORT OPERATIONS


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   HQ CORE EQUIP:  CSS COMPUTER SYS, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-HQ03  (VER 2.0)


REFERENCE:
  TOE 07-246J4, HQ CO, INF BN  (TAB 20)
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RULE NUMBER: 23

IF:
       THE UNIT PROPONENT IS INFANTRY
  and  THE INFANTRY UNIT MISSION IS ENGAGE ENEMY MANEUVER UNITS
  and  THE INFANTRY MISSION-TASK IS CONDUCT MOUNTED ASSAULT WITH MIXED CALIBER
       WPNS


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  IN CORE EQUIP:  IN FIGHTING VEHICLE, ERC-P
  and  IN CORE EQUIP:  INDIV WPN, ERC-A
  and  IN CORE EQUIP:  SQUAD WPN, ERC-A
  and  IN CORE EQUIP:  BAYONET, ERC-A
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMLPETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-IN01  (VER 2.0)


REFERENCE:
  TOE 07-247J4, RIFLE CO, INF BN  (TAB 21)



RULE NUMBER: 24

IF:
       THE UNIT PROPONENT IS INFANTRY
  and  THE INFANTRY UNIT MISSION IS ENGAGE TANKS
  and  THE INFANTRY MISSION-TASK IS CONDUCT REINFORCING ANTI-ARMOR FIRES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  IN CORE EQUIP:  ANTI-TANK MSL, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-IN02  (VER 2.0)


REFERENCE:
  TOE 07-248J4, ANTI-ARMOR CO, INF BN  (TAB 22)
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RULE NUMBER: 25

IF:
       THE UNIT PROPONENT IS ORDINANCE
  and  THE ORDINANCE MISSION IS PROVIDE INTERMEDIATE MAINTENANCE TO BRIGADE
  and  THE ORDNANCE UNIT MISSION-TASK IS THROUGHPUT OF REPAIRABLES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  OR CORE EQUIP:  EQUIP SPECIFIC TEST SET, ERC-P
  and  OR CORE EQUIP:  EQUIP SPECIFIC TOOL SET, ERC-P
  and  OR CORE EQUIP:  PARTS STORAGE VAN, ERC-P
  and  OR CORE EQUIP:  CONTACT VEHICLE, ERC-P
  and  OR CORE EQUIP:  RECOVERY VEHICLE, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-OD01  (VER 2.0)


REFERENCE:
  TOE 43-004J4, MAINTENANCE CO, FWD SPT BN  (TAB 42)



RULE NUMBER: 26

IF:
       THE UNIT PROPONENT IS QUARTERMASTER
  and  THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and  THE QUARTERMASTER MISSION-TASK IS ISSUE CLASS II, IV VII SUPPLIES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  QM CORE EQUIP:  TRACTOR TRUCK, ERC-P
  and  QM CORE EQUIP:  SEMITRAILER (FLATBED), ERC-P
  and  QM CORE EQUIP:  SEMITRAILER (SUPPLY VAN), ERC-P
  and  QM CORE EQUIP:  LOADING RAMP VEHICLE, ERC-P
  and  QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-QM01  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)
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RULE NUMBER: 27

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS PROVIDE AMMUNITION TRANSFER POINT


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  CRANE, ERC-P
  and   QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM02  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)
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RULE NUMBER: 28

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS PROVIDE WATER SUPPLY POINT


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  FDW AREA WATER POINT SUPPLY SYS, ERC-P
  and   QM CORE EQUIP:  WATER PURIFICATION EQUIP, ERC-P
  and   QM CORE EQUIP:  COLLAPSIBLE FABRIC TANK, ERC-P
  and   QM CORE EQUIP:  CENTRIFUGE PUMP, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM03  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)
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RULE NUMBER: 29

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS ISSUE CLASS I SUPPLIES


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  LOADING RAMP VEHICLE, ERC-P
  and   QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM04  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)
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RULE NUMBER: 30

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS PROVIDE PETROLEUM STORAGE & ISSUE


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  FUEL SYSTEM SUPPLY POINT, ERC-P
  and   QM CORE EQUIP:  FWD AREA REFUELING POINT, ERC-P
  and   QM CORE EQUIP:  COLLAPSIBLE FABRIC DRUM, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM05  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)
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RULE NUMBER: 31

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS DIVISION SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS PROVIDE PETROLEUM DISTRIBUTION


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  SEMITRAILER (TANK), ERC-P
  and   QM CORE EQUIP:  TRACTOR TRUCK, ERC-P
  and   QM CORE EQUIP:  DISPENSING TANK & PUMP UNIT, ERC-P
  and   QM CORE EQUIP:  DISPENSING TANK UNIT, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM06  (VER 2.0)


REFERENCE:
  TOE 42-007J4, SUPPLY AND SERVICE CO, FWD SPT BN  (TAB 45)




RULE NUMBER: 32

IF:
        THE UNIT PROPONENT IS QUARTERMASTER
  and   THE QUARTERMASTER UNIT MISSION IS BRIGADE SUPPORT
  and   THE QUARTERMASTER MISSION-TASK IS ISSUE CLASS II, IV VII SUPPLIES


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   QM CORE EQUIP:  TRACTOR TRUCK, ERC-P
  and   QM CORE EQUIP:  SEMITRAILER (FLATBED), ERC-P
  and   QM CORE EQUIP:  SEMITRAILER (SUPPLY VAN), ERC-P
  and   QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-QM07  (VER 2.0)


REFERENCE:
  TOE 42-004J4, SUPPLY CO, FWD SPT BN  (TAB 41)
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```
RULE NUMBER: 33

IF:
       THE UNIT PROPONENT IS QUARTERMASTER
  and  THE QUARTERMASTER UNIT MISSION IS BRIGADE SUPPORT
  and  THE QUARTERMASTER MISSION-TASK IS PROVIDE AMMUNITION TRANSFER POINT


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  QM CORE EQUIP:  CRANE, ERC-P
  and  QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-QM08  (VER 2.0)


REFERENCE:
  TOE 42-004J4, SUPPLY CO, FWD SPT BN  (TAB 41)
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```
RULE NUMBER: 34

IF:
       THE UNIT PROPONENT IS QUARTERMASTER
  and  THE QUARTERMASTER UNIT MISSION IS BRIGADE SUPPORT
  and  THE QUARTERMASTER MISSION-TASK IS ISSUE CLASS I SUPPLIES


THEN:
       THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and  QM CORE EQUIP:  LOADING RAMP VEHICLE, ERC-P
  and  QM CORE EQUIP:  FORK LIFT, ERC-P
  and
  and  [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and  STOP - Probability=1


NOTE:
  RULE/COR-QM09  (VER 2.0)


REFERENCE:
  TOE 42-004J4, SUPPLY CO, FWD SPT BN  (TAB 41)
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```
RULE NUMBER: 35

IF:
        THE UNIT PROPONENT IS TRANSPORTATION
  and   THE TRANSPORTATION UNIT MISSION IS PROVIDE TRUCK TRANSPORT
  and   THE TRANSPORTATION MISSION-TASK IS LIGHT LOAD HAUL


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   TC CORE EQUIP:  CORGO TRUCK, 5T, ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-TC01  (VER 2.0)


REFERENCE:
  TOE 55-087J4, TRANSPORTATION MOTOR TRANSPORT CO, MAIN SPT BN,  (TAB 46)
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RULE NUMBER: 36

IF:
        THE UNIT PROPONENT IS TRANSPORTATION
  and   THE TRANSPORTATION UNIT MISSION IS PROVIDE TRUCK TRANSPORT
  and   THE TRANSPORTATION MISSION-TASK IS MEDIUM LOAD HAUL


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   TC CORE EQUIP:  TRACTOR TRUCK, 5T, ERC-P
  and   TC CORE EQUIP:  SEMITRAILER (FLATBED), ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-TC02  (VER 2.0)


REFERENCE:
  TOE 55-087J4, TRANSPORTATION MOTOR TRANSPORT CO, MAIN SPT BN,  (TAB 46)
```

```
RULE NUMBER: 37

IF:
        THE UNIT PROPONENT IS TRANSPORTATION
  and   THE TRANSPORTATION UNIT MISSION IS PROVIDE TRUCK TRANSPORT
  and   THE TRANSPORTATION MISSION-TASK IS HEAVY LOAD HAUL


THEN:
        THE UNIT CORE EQUIP/ERC ARE AS FOLLOWS:
  and   TC CORE EQUIP:  HET TRACTOR TRUCK, ERC-P
  and   TC CORE EQUIP:  SEMITRAILER (LOW BED), ERC-P
  and
  and   [CORE ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"
  and   STOP - Probability=1


NOTE:
  RULE/COR-TC03  (VER 2.0)


REFERENCE:
  TOE 55-087J4, TRANSPORTATION MOTOR TRANSPORT CO, MAIN SPT BN,
  (TAB 46)
```

APPENDIX I

SUPPORT EQUIPMENT RULES

I-1. INTRODUCTION. This appendix catalogs all the rules in the expert system associated with the classification of support equipment and the assignment of equipment readiness codes (ERC) to these equipment. The rules are provided for general reference.

a. In establishing the rules, a schema of equipment support relationship was developed and within in this schema, specific types of support identified (see Chapter 3).

b. Associated with each rule is a rule number assigned by the system. It is used during development and maintenance of the system to identify the rule for editing purposes. The rule number, or more precisely, the rule order in the system, has significance in the system operation. The rule sequence affects the order of rule search and, in turn, the efficiency of the search. The rule number has no particular significance to the system user, except as a convenient way of identifying the rule for discussion or documentation purposes.

c. As described in Chapter 4, each rule is constructed using standardized text grouped into an IF-Part and a THEN-Part. The IF-Part contains one or more statements which if all are true, means that all the statements contained in the THEN-Part are true. For the rules in this appendix, the IF-Part of each rule defines a particular combination of support relationships and equipment usage conditions. The relationships are arranged in a hierarchal order, such that the first relationship is the most general and the following relationships become progressive more specific. The THEN-Part of the identifies the basic support relationship present, and assigns the ERC for this combination of support conditions.

I-2. INDIVIDUAL SUPPORT EQUIPMENT RULES. The individual rules, as shown in the following ages, reflect the order of the rules in the present system. They were produce, via printout from the system, using an option available in the editing process.

```
RULE NUMBER: 1

IF:
       THE PRESENT EQUIP HAS BEEN RECOMMENDED BY ADVISOR AS A CORE EQUIP

THEN:
       THE SUPPORT RELATIONSHIP IS:    CORE EQUIP
  and  THE READINESS CODE ADVISED IS:  CORE          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "CORE"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"

NOTE:
  RULE/CORE    (VER 2.0)



RULE NUMBER: 2

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES FIELD ALIGNMENT-REGISTERING OF SUPPORTED EQUIP
  and  THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE

THEN:
       THE SUPPORT RELATIONSHIP IS:    INITIALIZE CORE EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A         - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T1-01"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"

NOTE:
  RULE/TIER1-01  (VER 2.0)



RULE NUMBER: 3

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES CONTROL OF OPERATION OF SUPPORTED EQUIP
  and  THE CONTROL INVOLVES RADIO TRANSMISSION OF ORDERS or PROCESSING OF
       CONTROL SIGNALS or FACILITIES FOR DECISION MAKING
  and  THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE

THEN:
       THE SUPPORT RELATIONSHIP IS:    CONTROL CORE EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A         - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T1-02"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"

NOTE:
  RULE/TIER1-02  (VER 2.0)
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RULE NUMBER: 4

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES EXTERNAL SUPPLY OF ELECTRICAL POWER FOR SUPPORTED
        EQUIP
  and   THE EXTERNAL POWER IS A DIESEL GENERATOR SET or A BATTERY PACK or
        PROVIDED FROM REGULAR VEHICLE POWER SUPPLY or PROVIDED BY A SPECIAL
        POWER SUPPLY VEHICLE
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    POWER CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A         - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-03"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-03  (VER 2.0)
```

```
RULE NUMBER: 5

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES RESUPPLY OF RESOURCES CONSUMED BY SUPPORTED EQUIP
  and   THE RESUPPLY OCCURS DURING COMBAT OPERATIONS
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    SUSTAIN CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A         - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-04"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-04  (VER 2.0)
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RULE NUMBER: 6

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES MOVING SUPPORTED EQUIP INTO POSITION FOR OPERATION
  and   AFTER MOVEMENT OF THE EQUIP, THE PRESENT EQUIP REMAINS PHYSICALLY
        ATTACHED TO THE EQUIP or REMAINS NEARBY AWAITING NEXT MOVEMENT


THEN:
        THE SUPPORT RELATIONSHIP IS:    POSITION CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-05"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-05  (VER 2.0)
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RULE NUMBER: 7

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES ADAPTING SUPPORTED EQUIP FOR OPERATIONAL USE
  and   THE EQUIP IS ADAPTED WITH AN INSTALLATION KIT or AN ACCESSORY KIT or A
        TIE-DOWN FIXTURE or A COUPLING DEVICE or A SUPPORT MOUNT
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    ADAPT CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-06"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-06  (VER 2.0)
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RULE NUMBER: 8

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES MOVING SUPPORTED EQUIP INTO POSITION FOR OPERATION
  and   AFTER MOVEMENT OF THE EQUIP, THE PRESENT EQUIP IS AVAILABLE TO MOVE
        OTHER EQUIP


THEN:
        THE SUPPORT RELATIONSHIP IS:    TRANSPORT CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B         - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-07"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-07  (VER 2.0)



RULE NUMBER: 9

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES REPAIR-SERVICE OF SUPPORTED EQUIP
  and   THE REPAIR-SERVICE IS DONE WITH EQUIP UNIQUE TO SUPPORTED EQUIP or
        EQUIP DEDICATED TO USE WITH SUPPORTED EQUIP


THEN:
        THE SUPPORT RELATIONSHIP IS:    MAINTAIN CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B         - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-08"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-08  (VER 2.0)



RULE NUMBER: 10

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES RESUPPLY OF RESOURCES CONSUMED BY SUPPORTED EQUIP
  and   THE RESUPPLY OCCURS BETWEEN COMBAT OPERATIONS


THEN:
        THE SUPPORT RELATIONSHIP IS:    SUPPLY CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B         - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-09"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-09  (VER 2.0)
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RULE NUMBER: 11

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES SHELTER OF SUPPORTED EQUIP
  and   THE SHELTER PROVIDES ENCLOSED SPACE FOR EQUIP OPERATION or COVERING FOR
        EQUIP OPERATING AREA

THEN:
        THE SUPPORT RELATIONSHIP IS:    SHELTER CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-10"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"

NOTE:
  RULE/TIER1-10  (VER 2.0)
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RULE NUMBER: 12

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES ENHANCING OPERATION OF SUPPORTED EQUIP
  and   THE ENHANCEMENT PROVIDES INCREASED RADIO RANGE or REDUCED ANTENNA
        SIGNATURE or INCREASED COMMUNICATIONS SECURITY or NIGHT WEAPON
        SIGHTING or BOOM EXTENSION ON CRANE or INCREASED PUMPING CAPACITY
  and   THE SUPPORT IS PROVIDED AS AN OPTIONAL CONDITION OF OPERATIONAL USE

THEN:
        THE SUPPORT RELATIONSHIP IS:    ENHANCE CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-11"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"

NOTE:
  RULE/TIER1-11  (VER 2.0)
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```
RULE NUMBER: 13

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES AN ALTERNATE/BACK-UP CAPABILITY FOR SUPPORTED
        EQUIP
  and   THE ALTERNATE/BACK-UP CAPABILITY INVOLVES WIRE COMMUNICATIONS IN LIEU
        OF RADIO
  and   THE SUPPORT IS PROVIDED AS AN OPTIONAL CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    BACK-UP CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-12"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-12  (VER 2.0)
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RULE NUMBER: 14

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES EXERCISING OPERATION OF SUPPORTED EQUIP
  and   THE EXERCISE PROVIDES SIMULATION OF EQUIP LOCK-ON or SIMULATION OF
        EQUIP ROUND IN PLACE or SIMULATION OF EQUIP ROUND FIRING
  and   THE SUPPORT IS PROVIDED AS AN OPTIONAL CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    EXERCISE CORE EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-C          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T1-13"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER1-13  (VER 2.0)
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RULE NUMBER: 15

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES FIELD ALIGNMENT-REGISTERING OF SUPPORTED EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    INITIALIZE NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-01"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-01  (VER 2.0)
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RULE NUMBER: 16

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES CONTROL OF OPERATION OF SUPPORTED EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE CONTROL INVOLVES RADIO TRANSMISSION OF ORDERS or PROCESSING OF
        CONTROL SIGNALS or FACILITIES FOR DECISION MAKING
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    CONTROL NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-02"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-02  (VER 2.0)
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```
RULE NUMBER: 17

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES EXTERNAL SUPPLY OF ELECTRICAL POWER FOR SUPPORTED
        EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE EXTERNAL POWER IS A DIESEL GENERATOR SET or A BATTERY PACK or
        PROVIDED FROM REGULAR VEHICLE POWER SUPPLY or PROVIDED BY A SPECIAL
        POWER SUPPLY VEHICLE
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    POWER NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-03"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-03  (VER 2.0)



RULE NUMBER: 18

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES RESUPPLY OF RESOURCES CONSUMED BY SUPPORTED EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE RESUPPLY OCCURS DURING COMBAT OPERATIONS
  and   THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
        THE SUPPORT RELATIONSHIP IS:    SUSTAIN NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-04"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-04  (VER 2.0)
```

```
RULE NUMBER: 19

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES MOVING SUPPORTED EQUIP INTO POSITION FOR OPERATION
  and  THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and  AFTER MOVEMENT OF THE EQUIP, THE PRESENT EQUIP REMAINS PHYSICALLY
       ATTACHED TO THE EQUIP or REMAINS NEARBY AWAITING NEXT MOVEMENT


THEN:
       THE SUPPORT RELATIONSHIP IS:    POSITION NON-CORE, ERC-A EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T2-05"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-05  (VER 2.0)
```

```
RULE NUMBER: 20

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES ADAPTING SUPPORTED EQUIP FOR OPERATIONAL USE
  and  THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and  THE EQUIP IS ADAPTED WITH AN INSTALLATION KIT or AN ACCESSORY KIT or A
       TIE-DOWN FIXTURE or A COUPLING DEVICE
  and  THE SUPPORT IS PROVIDED AS A NECESSARY CONDITION OF OPERATIONAL USE


THEN:
       THE SUPPORT RELATIONSHIP IS:    ADAPT NON-CORE, ERC-A EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T2-06"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-06  (VER 2.0)
```

```
RULE NUMBER: 21

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES MOVING SUPPORTED EQUIP INTO POSITION FOR OPERATION
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   AFTER MOVEMENT OF THE EQUIP, THE PRESENT EQUIP IS AVAILABLE TO MOVE
        OTHER EQUIP


THEN:
        THE SUPPORT RELATIONSHIP IS:    TRANSPORT NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-07"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-07  (VER 2.0)
```

```
RULE NUMBER: 22

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES REPAIR-SERVICE OF SUPPORTED EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE REPAIR-SERVICE IS DONE WITH EQUIP UNIQUE TO SUPPORTED EQUIP or
        EQUIP DEDICATED TO USE WITH SUPPORTED EQUIP


THEN:
        THE SUPPORT RELATIONSHIP IS:    MAINTAIN NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-08"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-08  (VER 2.0)
```

```
RULE NUMBER: 23

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES RESUPPLY OF RESOURCES CONSUMED BY SUPPORTED EQUIP
  and  THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and  THE RESUPPLY OCCURS BETWEEN COMBAT OPERATIONS


THEN:
       THE SUPPORT RELATIONSHIP IS:    SUPPLY NON-CORE, ERC-A EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-B         - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T2-09"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-09  (VER 2.0)
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RULE NUMBER: 24

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and  THE SUPPORT INVOLVES SHELTER OF SUPPORTED EQUIP
  and  THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and  THE SHELTER PROVIDES ENCLOSED SPACE FOR EQUIP OPERATION or COVERING FOR
       EQUIP OPERATING AREA


THEN:
       THE SUPPORT RELATIONSHIP IS:    PROTECT NON-CORE, ERC-A EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-B         - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "T2-10"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-10  (VER 2.0)
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RULE NUMBER: 25

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE SUPPORT INVOLVES ENHANCING OPERATION OF SUPPORTED EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-A
  and   THE ENHANCEMENT PROVIDES INCREASED RADIO RANGE or REDUCED ANTENNA
        SIGNATURE or INCREASED COMMUNICATIONS SECURITY or NIGHT WEAPON
        SIGHTING or BOOM EXTENSION ON CRANE or INCREASED PUMPING CAPACITY


THEN:
        THE SUPPORT RELATIONSHIP IS:    ENHANCE NON-CORE, ERC-A EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-11"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-11  (VER 2.0)



RULE NUMBER: 26

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE ERC OF THE SUPPORTED NON-CORE EQUIP IS ERC-B


THEN:
        THE SUPPORT RELATIONSHIP IS:    SUPPORT NON-CORE, ERC-B EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "T2-12"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/TIER2-12  (VER 2.0)



RULE NUMBER: 27

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
  and   THE UNIT SUPPORT IS IN THE FORM OF NBC DEFENSE
  and   THE PRESENT UNIT NBC DEFENSE EQUIP IS A GAS PARTICULATE FILTER UNIT


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-01"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-01  (VER 2.0)
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RULE NUMBER: 28

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF NBC DEFENSE
  and   THE PRESENT UNIT NBC DEFENSE EQUIP IS A DETECTOR or A MONITOR or A
        RADIACMETER or A CHARGER or A DECON APPARATUS or A PORTABLE DECON
        APPARATUS or A COLLECTIVE SHELTER


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-02"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-02  (VER 2.0)



RULE NUMBER: 29

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF CONCEALMENT OF UNIT ASSETS
  and   THE PRESENT UNIT CONCEALMENT EQUIP IS A SMOKE GENERATOR


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-03"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-03  (VER 2.0)



RULE NUMBER: 30

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF CONCEALMENT OF UNIT ASSETS
  and   THE PRESENT UNIT CONCEALMENT EQUIP IS A CAMOUFLAGE SYSTEM


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-C          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-04"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-04  (VER 2.0)
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RULE NUMBER: 31

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and  THE UNIT SUPPORT IS IN THE FORM OF ACTIVE DEFENSE
  and  THE DEPLOYMENT OF UNIT WITHIN COMBAT ENVIRONMENT EMPHASIZES THE NEED
       FOR DEFENSIVE CAPABILITY
  and  THE PRESENT UNIT POSITION-ENROUTE DEFENSE EQUIP IS AN INDIVIDUAL WEAPON
       or A CREW SERVED WEAPON or A WEAPON MOUNT


THEN:
       THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "UN-05"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-05  (VER 2.0)
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RULE NUMBER: 32

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and  THE UNIT SUPPORT IS IN THE FORM OF ACTIVE DEFENSE
  and  THE DEPLOYMENT OF UNIT WITHIN COMBAT ENVIRONMENT DEEMPHASIZES THE NEED
       FOR DEFENSIVE CAPABILITY
  and  THE PRESENT UNIT POSITION-ENROUTE DEFENSE EQUIP IS AN INDIVIDUAL WEAPON
       or A CREW SERVED WEAPON or A WEAPON MOUNT or A BAYONET


THEN:
       THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "UN-06"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-06  (VER 2.0)
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RULE NUMBER: 33

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF PERSONNEL SERVICE
  and   THE PRESENT UNIT PERSONNEL SERVICE EQUIP IS A FOOD SERVICE FIXTURE


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-C          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-07"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-07  (VER 2.0)



RULE NUMBER: 34

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF PERSONNEL SERVICE
  and   THE PRESENT UNIT PERSONNEL SERVICE EQUIP IS A WATER SUPPLY TRAILER


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-08"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-08  (VER 2.0)



RULE NUMBER: 35

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and   THE UNIT SUPPORT IS IN THE FORM OF WORKING ENVIRONMENT SUPPORT
  and   THE WORK ACTIVITY INVOLVES EQUIP CODED ERC-A
  and   THE PRESENT UNIT WORKING ENVIRONMENT EQUIP IS A LIGHT SET


THEN:
        THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "UN-09"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-09  (VER 2.0)
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RULE NUMBER: 36

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and  THE UNIT SUPPORT IS IN THE FORM OF WORKING ENVIRONMENT SUPPORT
  and  THE WORK ACTIVITY INVOLVES EQUIP CODED ERC-B
  and  THE PRESENT UNIT WORKING ENVIRONMENT EQUIP IS A LIGHT SET


THEN:
       THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "UN-10"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-10  (VER 2.0)



RULE NUMBER: 37

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and  THE UNIT SUPPORT IS IN THE FORM OF WORKING ENVIRONMENT SUPPORT
  and  THE WORK ACTIVITY INVOLVES EQUIP CODED ERC-A
  and  THE PRESENT UNIT WORKING ENVIRONMENT EQUIP IS AN AIR CONDITIONER


THEN:
       THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "UN-11"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-11  (VER 2.0)



RULE NUMBER: 38

IF:
       [ERC ASSIGNMENT] = "NOT COMPLETED"
  and  THE PRESENT EQUIP SUPPORTS THE UNIT AS A WHOLE
  and  THE UNIT SUPPORT IS IN THE FORM OF WORKING ENVIRONMENT SUPPORT
  and  THE WORK ACTIVITY INVOLVES EQUIP CODED ERC-B
  and  THE PRESENT UNIT WORKING ENVIRONMENT EQUIP IS AN AIR CONDITIONER


THEN:
       THE SUPPORT RELATIONSHIP IS:    UNIT SUPPORT EQUIP
  and  THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and  [RULE NUMBER] IS GIVEN THE VALUE "UN-12"
  and  [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/UNIT-12  (VER 2.0)
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RULE NUMBER: 39

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED ABILITY TO ASSESS
        SITUATION
  and   NIGHT SURVEILLANCE IS A PRIMARY MISSION REQUIREMENT
  and   THE PRESENT INDIVIDUAL ASSESSMENT EQUIP IS A NIGHT VISION DEVICE


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-A          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-01"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-01  (VER 2.0)
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RULE NUMBER: 40

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED ABILITY TO ASSESS
        SITUATION
  and   NIGHT SURVEILLANCE IS NOT A PRIMARY MISSION REQUIREMENT
  and   THE PRESENT INDIVIDUAL ASSESSMENT EQUIP IS A NIGHT VISION DEVICE


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-02"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-02  (VER 2.0)
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RULE NUMBER: 41

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED ABILITY TO ASSESS
        SITUATION
  and   THE PRESENT INDIVIDUAL ASSESSMENT EQUIP IS A SET OF BINOCULARS or A
        MINE DETECTOR


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-03"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-03  (VER 2.0)



RULE NUMBER: 42

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED ABILITY TO ASSESS
        SITUATION
  and   THE PRESENT INDIVIDUAL ASSESSMENT EQUIP IS A WATCH


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-C          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-04"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-04  (VER 2.0)



 RULE NUMBER: 43

 IF:
         [ERC ASSIGNMENT] = "NOT COMPLETED"
   and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
   and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF PERSONAL MOBILITY
   and   THE PRESENT INDIVIDUAL MOBILITY EQUIP IS A VEHICLE ASSIGNED TO CHAPLAIN


 THEN:
         THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
   and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
   and
   and   [RULE NUMBER] IS GIVEN THE VALUE "IN-05"
   and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


 NOTE:
   RULE/INDIV-05  (VER 2.0)
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RULE NUMBER: 44

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF IMPROVED PRODUCTIVITY
  and   THE PRESENT INDIVIDUAL PRODUCTIVITY EQUIP IS A COMMERCIAL GRADE POWER
        TOOL or A DUPLICATING MACHINE or A SEALING IRON or A SIGN PAINTING KIT


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-C          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-06"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-06  (VER 2.0)



RULE NUMBER: 45

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"
  and   THE PRESENT EQUIP SUPPORTS AN INDIVIDUAL WITHIN UNIT
  and   THE INDIVIDUAL SUPPORT IS IN THE FORM OF BASIC TOOLS-APPARATUS TO APPLY
        SKILLS
  and   THE PRESENT INDIVIDUAL SKILL APPLICATION EQUIP IS A STANDARD TOOL SET
        or A STANDARD TEST SET or A DEMOLITION SET or A PIONEER SET or A
        CARPENTER SET


THEN:
        THE SUPPORT RELATIONSHIP IS:    INDIVIDUAL SUPPORT EQUIP
  and   THE READINESS CODE ADVISED IS:  ERC-B          - Probability=1
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "IN-07"
  and   [ERC ASSIGNMENT] IS GIVEN THE VALUE "COMPLETED"


NOTE:
  RULE/INDIV-07   (VER 2.0)



RULE NUMBER: 46

IF:
        [ERC ASSIGNMENT] = "NOT COMPLETED"


THEN:
        THE READINESS CODE ADVISED IS:  NOT POSSIBLE       - Probability=1
  and
  and   NO ERC CAN BE ASSIGNED TO THIS EQUIP ITEM BASED ON GIVEN RESPONSES
  and
  and   [RULE NUMBER] IS GIVEN THE VALUE "SY-01"


NOTE:
  RULE/SYS-01   (VER 2.0)
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APPENDIX J

CORE EQUIPMENT STATEMENTS

J-1. INTRODUCTION. This appendix catalogs all the semantic statements which are used in the core equipment rules. It includes a cross-reference to the core equipment rule in which the statement appears.

a. As described in Chapter 4, a semantic statement is one which is comprised of two parts, a QUALIFER and VALUE. The QUALIFER sets up the first part of an assertion, and the VALUE completes the assertion in a specific manner. Each QUALIFER used in the system has one or more VALUEs which reflect the variations in the way the assertion is used in the rules.

b. The appendix lists each QUALIFER in turn, and shows the VALUEs currently assigned. The order of the statements follows the order in which they were input into the system. Each QUALIFER is assigned a reference number at the time of input. This number is subsequently used to identify the QUALIFER during the development and maintenance of the system.

c. More specifically, this appendix consists of the statements used in the core equipment rules. The statements are organized alphabetically, by branch within the Army. For system purposes, headquarters units are treated as separate entities, not related to any branch. For each branch there is:

- A statement which identifies the missions of company size units within the branch.
- A statement which identifies the mission-tasks of company size units within the branch.
- A statement which identifies the core equipments as used in the company size units within the branch.

J-2. INDIVIDUAL CORE EQUIPMENT STATEMENTS. The individual statements, as shown in the following pages, reflect the order of the statements in the present system. They were produced, via printout from the system, using an option available in the editing process.

QUALIFIERS:

1 THE UNIT PROPONENT IS

AIR DEFENSE ARTILLERY
ARMOR
AVIATION
ENGINEEER
FIELD ARTILLERY
LOGISTICS CENTER
INFANTRY
ORDINANCE
QUARTERMASTER
TRANSPORTATION

NONE OF ABOVE

Used in rule(s): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37

2 THE AIR DEFENSE UNIT MISSION IS

ENGAGE ENEMY AIRCRAFT

NONE OF ABOVE

Used in rule(s): 1

3 THE AIR DEFENSE MISSION-TASK IS

FORWARD AIR DEFENSE AGAINST LOW LEVEL SORTIES

NONE OF ABOVE

Used in rule(s): 1

4 AD CORE EQUIP:

MAN PORTABLE AD MSL, ERC-P

Used in rule(s): (1)

5 THE ARMOR UNIT MISSION IS

ENGAGE ENEMY MANUEVER UNITS
RECONNOITER ENEMY

NONE OF ABOVE

Used in rule(s): 2 3 4

6 THE ARMOR MISSION-TASK IS

CONDUCT TANK ASSUALT USING MIXED CALIBER FIRES
GROUND SEARCH OF DESIGNATED AREA
AIRBORNE SEARCH OF DESIGNATED AREA

NONE OF ABOVE

Used in rule(s): 2 3 4

7 AR CORE EQUIP:

TANK, ERC-P
CAV FIGHTING VEHICLE, ERC-P
OBSN HEL, ERC-P

Used in rule(s): (2) (3) (4)

8 THE AVIATION UINT MISSION IS

ENGAGE ENEMY ELEMENTS

NONE OF ABOVE

Used in rule(s): 5

9 THE AVIATION MISSION-TASK IS

AIRBRONE ATTACK WITH MIXED ORDINANCE FIRES

NONE OF ABOVE

Used in rule(s): 5

10 AV CORE EQUIP:

ATTACK HEL, ERC-P

Used in rule(s): (5)

11 THE ENGINEER UNIT MISSION IS

INCREASE DIVISION EFFECTIVENESS
EMPLACE WATER GAP CROSSINGS
UNIT MAINTENANCE

NONE OF ABOVE

Used in rule(s): 6 7 8 9 10 11

12 THE ENGINEER MISSION-TASK IS

EARTHWORK AND ROADWORK CONSTRUCTION
EMPLACE ASSUALT BRIDGING
PREPARE BATTLE POSITIONS
UNIT MAINTENANCE
EMPLACE GAP CROSSING SYSTEM
THROUGHPUT OF REPAIRABLES

NONE OF ABOVE

Used in rule(s): 6 7 8 9 10 11

13 EN CORE EQUIP:

SCOOPER-LOADER, ERC-P
SCRAPER, ERC-P
DUMP TRUCK, ERC-P
TRACTOR, ERC=P
ASLT BRIDGE LAUNCHER, ERC-P
ASLT BRIDGE SECTIONS, ERC-P
ARMORED COMBAT EARTHMOVER, ERC-P
RECOVERY VEHICLE, ERC-P
WRECKER, ERC-P
GAP CROSSING SYS, ERC-P
CONTACT VEHICLE, ERC-A

Used in rule(s): (6) (7) (8) (9) (10) (11)

14 THE FIELD ARTILLERY UNIT MISSION IS

ENGAGE ENEMY WITH INDIRECT FIRES
LOCATE ENEMY FOR ENGAGEMENT
SERVICE FA BN

NONE OF ABOVE

Used in rule(s): 12 13 14 15 16 17
18 19

15 THE FIELD ARTILLERY MISSION-TASK IS

CONDUCT INDIRECT HEAVY CALIBER FIRES
CONDUCT MASSED ROCKET FIRES
LOCATE ENEMY MOVEMENT
LOCATE ENEMY ARTILLERY
LOCATE ENEMY MORTARS
SUPPLY CLASS I, II, III, VII ITEMS
PROVIDE AMMUNITION TRANSFER POINT
AUTOMOTIVE MAINTENANCE SUPPORT

NONE OF ABOVE

Used in rule(s): 12 13 14 15 16 17
18 19

16 FA CORE EQUIP:

HEAVY CALIBER CANNON, ERC-P
MULTIPLE RKT LAUNCHER SYS, ERC-P
MOVING TGT LOC RADAR, ERC-P
ARTY LOC RADAR, ERC-P
MORTAR LOC RADAR, ERC-P
TANK TRUCK, ERC-A
TANK & PUMP UNIT, ERC-A
TANK UNIT, ERC-A
CARGO TRUCK, ERC-A
CARGO TRUCK WITH CRANE, ERC-A
EQUIP SPECIFIC TEST SET, ERC-A
EQUIP SPECIFIC TOOL SET, ERC-A
PARTS STORAGE VAN, ERC-A
CONTACT VEHICLE, ERC-A
RECOVERY VEHICLE, ERC-A

Used in rule(s): (12) (13) (14) (15) (16) (17)
(18) (19)

17 THE UNIT MISSION IS

PROVIDE COMMAND, CONTROL AND SUPERVISION OF BN OPERATIONS
PROVIDE SUPERVISION OF OPERATIONS

NONE OF ABOVE

Used in rule(s): 20 21 22

18 THE HEADQUARTERS MISSION-TASK IS

CONDUCT TACTICAL OPERATIONS
CONDUCT SUPPORT OPERATIONS
CONDUCT CO SUPPORT OPERATIONS

NONE OF ABOVE

Used in rule(s): 20 21 22

19 HQ CORE EQUIP:

COMMANDER VEHICLE, ERC-A
SECTION CHIEF VEHICLE, ERC-A
COMMAND NET RADIO, ERC-A
ADMIN-LOG NET RADIO, ERC-A
CSS COMPUTER SYS, ERC-P

Used in rule(s): (20) (21) (22)

20 THE INFANTRY UNIT MISSION IS

ENGAGE ENEMY MANEUVER UNITS
ENGAGE TANKS

NONE OF ABOVE

Used in rule(s): 23 24

21 THE INFANTRY MISSION-TASK IS

CONDUCT MOUNTED ASSAULT WITH MIXED CALIBER WPNS
CONDUCT REINFORCING ANTI-ARMOR FIRES

NONE OF ABOVE

Used in rule(s): 23 24

22 IN CORE EQUIP:

IN FIGHTING VEHICLE, ERC-P
INDIV WPN, ERC-A
SQUAD WPN, ERC-A
BAYONET, ERC-A
ANTI-TANK MSL, ERC-P

Used in rule(s): (23) (24)

23 THE ORDINANCE MISSION IS

PROVIDE INTERMEDIATE MAINTENANCE TO BRIGADE

NONE OF ABOVE

Used in rule(s): 25

24 THE ORDNANCE UNIT MISSION-TASK IS

THROUGHPUT OF REPAIRABLES

NONE OF ABOVE

Used in rule(s): 25

25 OR CORE EQUIP:

EQUIP SPECIFIC TEST SET, ERC-P
EQUIP SPECIFIC TOOL SET, ERC-P
PARTS STORAGE VAN, ERC-P
CONTACT VEHICLE, ERC-P
RECOVERY VEHICLE, ERC-P

Used in rule(s): (25)

26 THE QUARTERMASTER UNIT MISSION IS

DIVISION SUPPORT
BRIGADE SUPPORT

NONE OF ABOVE

Used in rule(s): 26 27 28 29 30 31
32 33 34

27 THE QUARTERMASTER MISSION-TASK IS

ISSUE CLASS II, IV VII SUPPLIES
PROVIDE AMMUNITION TRANSFER POINT
PROVIDE WATER SUPPLY POINT
ISSUE CLASS I SUPPLIES
PROVIDE PETROLEUM STORAGE & ISSUE
PROVIDE PETROLEUM DISTRIBUTION

NONE OF ABOVE

Used in rule(s): 26 27 28 29 30 31
32 33 34

28 QM CORE EQUIP:

TRACTOR TRUCK, ERC-P
SEMITRAILER (FLATBED), ERC-P
SEMITRAILER (SUPPLY VAN), ERC-P
LOADING RAMP VEHICLE, ERC-P
FORK LIFT, ERC-P
CRANE, ERC-P
FDW AREA WATER POINT SUPPLY SYS, ERC-P
WATER PURIFICATION EQUIP, ERC-P
COLLAPSIBLE FABRIC TANK, ERC-P
CENTRIFUGE PUMP, ERC-P
FUEL SYSTEM SUPPLY POINT, ERC-P
FWD AREA REFUELING POINT, ERC-P
COLLAPSIBLE FABRIC DRUM, ERC-P
SEMITRAILER (TANK), ERC-P
DISPENSING TANK & PUMP UNIT, ERC-P
DISPENSING TANK UNIT, ERC-P

Used in rule(s): (26) (27) (28) (29) (30) (31)
(32) (33) (34)

29 THE TRANSPORTATION UNIT MISSION IS

PROVIDE TRUCK TRANSPORT

NONE OF ABOVE

Used in rule(s): 35 36 37

30 THE TRANSPORTATION MISSION-TASK IS

LIGHT LOAD HAUL
MEDIUM LOAD HAUL
HEAVY LOAD HAUL

NONE OF ABOVE

Used in rule(s): 35 36 37

31 TC CORE EQUIP:

CORGO TRUCK, 5T, ERC-P
TRACTOR TRUCK, 5T, ERC-P
SEMITRAILER (FLATBED), ERC-P
HET TRACTOR TRUCK, ERC-P
SEMITRAILER (LOW BED), ERC-P

Used in rule(s): (35) (36) (37)

APPENDIX K

SUPPORT EQUIPMENT STATEMENTS

K-1. INTRODUCTION. This appendix catalogs all the semantic statements which are used in the support equipment rules. It includes a cross-reference to the support equipment rule in which the statement appears. The statements are provided for general reference.

a. As described in Chapter 4, a semantic statement is one which is comprised of two parts, a QUALIFER and VALUE. The QUALIFER sets up the first part of an assertion, and the VALUE completes the assertion in a specific manner. Each QUALIFER used in the system has one or more VALUEs which reflect the variations in the way the assertion is used in the rules.

b. This appendix lists each QUALIFER, in turn, and shows the VALUEs currently assigned. The order of the statements follows the order in which there were input into the system. Each QUALIFER is assigned a reference number at the time of input. This number is subsequently used to identify the QUALIFER during the development and maintenance of the system.

c. More specifically, this appendix consists of statements used in the support equipment rules. The statements are ordered by:

- Tier 1 support equipment statements
- Tier 2 support equipment statements
- Unit-level support equipment statements
- Individual-level support equipment statements

K-2. INDIVIDUAL SUPPORT EQUIPMENT STATEMENTS. The individual statements, as shown in the following pages, reflect the order of the statements in the present system. They were produced, via printout from the system, using an option available in the editing process.

QUALIFIERS:

1 THE PRESENT EQUIP

HAS BEEN RECOMMENDED BY ADVISOR AS A CORE EQUIP
DIRECTLY (TIER 1) SUPPORTS A CORE EQUIP
INDIRECTLY (TIER 2) SUPPORTS A CORE EQUIP
SUPPORTS THE UNIT AS A WHOLE
SUPPORTS AN INDIVIDUAL WITHIN UNIT

NONE OF ABOVE

Used in rule(s):						
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31	32	33	34	35	36
	37	38	39	40	41	42
	43	44	45			

2 THE SUPPORT INVOLVES

FIELD ALIGNMENT-REGISTERING OF SUPPORTED EQUIP
CONTROL OF OPERATION OF SUPPORTED EQUIP
EXTERNAL SUPPLY OF ELECTRICAL POWER FOR SUPPORTED EQUIP
RESUPPLY OF RESOURCES CONSUMED BY SUPPORTED EQUIP
MOVING SUPPORTED EQUIP INTO POSITION FOR OPERATION
ADAPTING SUPPORTED EQUIP FOR OPERATIONAL USE
REPAIR-SERVICE OF SUPPORTED EQUIP
SHELTER OF SUPPORTED EQUIP
ENHANCING OPERATION OF SUPPORTED EQUIP
AN ALTERNATE/BACK-UP CAPABILITY FOR SUPPORTED EQUIP
EXERCISING OPERATION OF SUPPORTED EQUIP

NONE OF ABOVE

Used in rule(s):						
	2	3	4	5	6	7
	8	9	10	11	12	13
	14	15	16	17	18	19
	20	21	22	23	24	25

3 THE SUPPORT IS PROVIDED AS

A NECESSARY CONDITION OF OPERATIONAL USE
AN OPTIONAL CONDITION OF OPERATIONAL USE

Used in rule(s):						
	2	3	4	5	7	12
	13	14	15	16	17	18
	20					

4 THE SUPPORT RELATIONSHIP IS:

INITIALIZE CORE EQUIP
CONTROL CORE EQUIP
POWER CORE EQUIP
SUSTAIN CORE EQUIP
POSITION CORE EQUIP
ADAPT CORE EQUIP
TRANSPORT CORE EQUIP
MAINTAIN CORE EQUIP
SUPPLY CORE EQUIP
SHELTER CORE EQUIP
ENHANCE CORE EQUIP
BACK-UP CORE EQUIP
EXERCISE CORE EQUIP
INITIALIZE NON-CORE, ERC-A EQUIP
CONTROL NON-CORE, ERC-A EQUIP
POWER NON-CORE, ERC-A EQUIP
SUSTAIN NON-CORE, ERC-A EQUIP
POSITION NON-CORE, ERC-A EQUIP
ADAPT NON-CORE, ERC-A EQUIP
TRANSPORT NON-CORE, ERC-A EQUIP
MAINTAIN NON-CORE, ERC-A EQUIP
SUPPLY NON-CORE, ERC-A EQUIP
PROTECT NON-CORE, ERC-A EQUIP
ENHANCE NON-CORE, ERC-A EQUIP
SUPPORT NON-CORE, ERC-B EQUIP
UNIT SUPPORT EQUIP
INDIVIDUAL SUPPORT EQUIP
CORE EQUIP

Used in rule(s): (1) (2) (3) (4) (5) (6)
(7) (8) (9) (10) (11) (12)
(13) (14) (15) (16) (17) (18)
(19) (20) (21) (22) (23) (24)
(25) (26) (27) (28) (29) (30)
(31) (32) (33) (34) (35) (36)
(37) (38) (39) (40) (41) (42)
(43) (44) (45)

5 THE CONTROL INVOLVES

RADIO TRANSMISSION OF ORDERS
PROCESSING OF CONTROL SIGNALS
FACILITIES FOR DECISION MAKING

NONE OF ABOVE

Used in rule(s): 3 16

6 THE EXTERNAL POWER IS

A DIESEL GENERATOR SET
A BATTERY PACK
PROVIDED FROM REGULAR VEHICLE POWER SUPPLY
PROVIDED BY A SPECIAL POWER SUPPLY VEHICLE

NONE OF ABOVE

Used in rule(s): 4 17

7 THE RESUPPLY OCCURS

DURING COMBAT OPERATIONS
BETWEEN COMBAT OPERATIONS

NONE OF ABOVE

Used in rule(s): 5 10 18 23

8 AFTER MOVEMENT OF THE EQUIP, THE PRESENT EQUIP

REMAINS PHYSICALLY ATTACHED TO THE EQUIP
REMAINS NEARBY AWAITING NEXT MOVEMENT
IS AVAILABLE TO MOVE OTHER EQUIP

NONE OF ABOVE

Used in rule(s): 6 8 19 21

9 THE EQUIP IS ADAPTED WITH

AN INSTALLATION KIT
AN ACCESSORY KIT
A TIE-DOWN FIXTURE
A COUPLING DEVICE
A SUPPORT MOUNT

NONE OF ABOVE

Used in rule(s): 7 20

10 THE REPAIR-SERVICE IS DONE WITH

EQUIP UNIQUE TO SUPPORTED EQUIP
EQUIP DEDICATED TO USE WITH SUPPORTED EQUIP

NONE OF ABOVE

Used in rule(s): 9 22

11 THE SHELTER PROVIDES

ENCLOSED SPACE FOR EQUIP OPERATION
COVERING FOR EQUIP OPERATING AREA

NONE OF ABOVE

Used in rule(s): 11 24

12 THE ENHANCEMENT PROVIDES

INCREASED RADIO RANGE
REDUCED ANTENNA SIGNATURE
INCREASED COMMUNICATIONS SECURITY
NIGHT WEAPON SIGHTING
BOOM EXTENSION ON CRANE
INCREASED PUMPING CAPACITY

NONE OF ABOVE

Used in rule(s): 12 25

13 THE ALTERNATE/BACK-UP CAPABILITY INVOLVES

WIRE COMMUNICATIONS IN LIEU OF RADIO

NONE OF ABOVE

Used in rule(s): 13

14 THE EXERCISE PROVIDES

SIMULATION OF EQUIP LOCK-ON
SIMULATION OF EQUIP ROUND IN PLACE
SIMULATION OF EQUIP ROUND FIRING

NONE OF ABOVE

Used in rule(s): 14

15 THE ERC OF THE SUPPORTED NON-CORE EQUIP IS

ERC-A
ERC-B
ERC-C

UNKNOWN

Used in rule(s): 15 16 17 18 19 20
21 22 23 24 25 26

16 THE UNIT SUPPORT IS IN THE FORM OF

NBC DEFENSE
CONCEALMENT OF UNIT ASSETS
ACTIVE DEFENSE
PERSONNEL SERVICE
WORKING ENVIRONMENT SUPPORT

NONE OF ABOVE

Used in rule(s): 27 28 29 30 31 32
33 34 35 36 37 38

17 THE WORK ACTIVITY INVOLVES EQUIP CODED

ERC-A
ERC-B
ERC-C

UNKNOWN

Used in rule(s): 35 36 37 38

18 THE INDIVIDUAL SUPPORT IS IN THE FORM OF

IMPROVED ABILITY TO ASSESS SITUATION
PERSONAL MOBILITY
IMPROVED PRODUCTIVITY
BASIC TOOLS-APPARATUS TO APPLY SKILLS

NONE OF ABOVE

Used in rule(s): 39 40 41 42 43 44 45

19 THE PRESENT INDIVIDUAL ASSESSMENT EQUIP IS

A NIGHT VISION DEVICE
A SET OF BINOCULARS
A MINE DETECTOR
A WATCH

NONE OF ABOVE

Used in rule(s): 39 40 41 42

20 THE PRESENT UNIT NBC DEFENSE EQUIP IS

A GAS PARTICULATE FILTER UNIT
A DETECTOR
A MONITOR
A RADIACMETER
A CHARGER
A DECON APPARATUS
A PORTABLE DECON APPARATUS
A COLLECTIVE SHELTER

NONE OF ABOVE

Used in rule(s): 27 28

21 THE PRESENT UNIT CONCEALMENT EQUIP IS

A SMOKE GENERATOR
A CAMOUFLAGE SYSTEM

NONE OF ABOVE

Used in rule(s): 29 30

22 THE PRESENT UNIT POSITION-ENROUTE DEFENSE EQUIP IS

AN INDIVIDUAL WEAPON
A CREW SERVED WEAPON
A WEAPON MOUNT
A BAYONET

NONE OF ABOVE

Used in rule(s): 31 32

23 THE PRESENT UNIT PERSONNEL SERVICE EQUIP IS

A FOOD SERVICE FIXTURE
A WATER SUPPLY TRAILER

NONE OF ABOVE

Used in rule(s): 33 34

24 THE PRESENT UNIT WORKING ENVIRONMENT EQUIP IS

A LIGHT SET
AN AIR CONDITIONER

NONE OF ABOVE

Used in rule(s): 35 36 37 38

25 THE DEPLOYMENT OF UNIT WITHIN COMBAT ENVIRONMENT

EMPHASIZES THE NEED FOR DEFENSIVE CAPABILITY
DEEMPHASIZES THE NEED FOR DEFENSIVE CAPABILITY

Used in rule(s): 31 32

26 NIGHT SURVEILLANCE IS

A PRIMARY MISSION REQUIREMENT
NOT A PRIMARY MISSION REQUIREMENT

Used in rule(s): 39 40

27 THE PRESENT INDIVIDUAL MOBILITY EQUIP IS

A VEHICLE ASSIGNED TO CHAPLAIN

NONE OF ABOVE

Used in rule(s): 43

29 THE PRESENT INDIVIDUAL SKILL APPLICATION EQUIP IS

A STANDARD TOOL SET
A STANDARD TEST SET
A DEMOLITION SET
A PIONEER SET
A CARPENTER SET

NONE OF ABOVE

Used in rule(s): 45

28 THE PRESENT INDIVIDUAL PRODUCTIVITY EQUIP IS

A COMMERCIAL GRADE POWER TOOL
A DUPLICATING MACHINE
A SEALING IRON
A SIGN PAINTING KIT

NONE OF ABOVE

Used in rule(s): 44

APPENDIX L

DEMONSTRATION ACTIVITY

L-1. INTRODUCTION. This appendix describes the demonstration activity which replaced the planned validation of the system.

L-2. BACKGROUND. As discussed in Chapter 5, the planned validation activity was not carried out due to problems associated with the terminology used in some of the system queries. These problems caused users to misinterpret what was being asked. As a result, some responses were inappropriate. This led to the unanticipated phenomena of the system providing correct ERC assignments when incorrect responses were given. There had been no provision for controlling for this condition in the validation plan. The presumption had been than any incorrect response by the system would be the result of an incorrect rule condition. With this presumption, the percent of the incorrect responses would measure the quality of the rules. What was experienced, however, was inappropriate inputs which contaminated the percent measure with components of both correct and incorrect responses. This effectively invalidated the basis for the measure. Given the limited time available for working with the field personnel, it was determined to demonstrate rather than validate the system, and seek a qualitative rather than quantitative measure of the system performance.

L-3. DEMONSTRATION OBJECTIVE. The objective of the demonstration was to acquaint the potential users of the system with the design, operation and current status of the system, using actual system inputs and outputs.

L-4. DEMONSTRATION PROCEDURE

a. The procedure for demonstrating the system was rule-oriented rather than TOE-oriented. That is, rather than selecting an equipment from a TOE, a rule was selected and responses made to the system queries to cause the rule to be used. This approach expedited the demonstration, since no particular TOE context was involved and the specifics of a particular equipment use, relative to a TOE, could be dispensed with. The approach was possible since the demonstration was given by the system developer, who was conversant with the rules present in the system and was therefore aware of the inputs needed to cause a particular rule to "fire," thus generating the desired system output.

b. The rules were both selected and demonstrated on an informal basis. Not all the rules were presented to both groups of observers (see paragraph L-5), and the order in which the rules were demonstrated did not necessarily follow the order described herein (see paragraph L-6).

L-5. DEMONSTRATION OBSERVERS. The demonstration was provided to two groups of observers:

- A group of three action officers with TOE review responsibilities.
- The chief of the TOE planning division and the TRADOC point of contact for the study.

L-6. CASES USED IN DEMONSTRATION

a. Case Selection Criteria. The cases for the demonstration were selected to be representative of:

- The manner in which the unit mission and mission-task leads to the identification of unit core equipment and the assignment of ERC "A" and ERC "P" codes.
- The manner in which the particular use of the equipment leads to the identification of the support relationship involved and the ERC (ERC-A, ERC-B, or ERC-C) assigned to the support conditions present.

b. Representativeness of Selection. An indication of the representativeness of the cases selected for use in the demonstration is shown in Table L-1. The rule types were demonstrated in varying degrees, as discussed below.

Table L-1. Representativeness of Rules Demonstrated

Rule type	Number of rules in system	Number of rules demonstrated
Core equipment	37	2
Support equipment		
Tier 1	13	7
Tier 2	12	2
Unit-level	12	3
Individual-level	7	2

(1) The core equipment rules present no conceptual difficulties. They involve cataloging unit mission and mission tasks and associating core equipments with each combination of mission and mission-task. This information is derived directly from existing documentation. It is readily available and requires only the briefest illustration to indicate the manner in which the documentation is reflected in the rule structure. Of the 37 core equipment rules in the systems, 2 were demonstrated.

(2) Emphasis was placed on the demonstration of the support equipment rules and particularly the Tier 1 support equipment. These rules illustrate the various modes of support relationships. Of the 13 Tier 1 support equipment rules in the system, 7 were demonstrated.

(3) The Tier 2 support equipment rules are similar to the Tier 1 rules, except that the ERC of the supported equipment is taken into account in assigning the ERC of the equipment being considered by the system. Given the similarity between the Tier 1 support equipment rules and the Tier 2 support equipment rules, only 2 out of the 12 Tier 2 support equipment rules were demonstrated.

(4) Both the Unit-level support equipment and the Individual-level support equipment rules are largely self-explanatory. A sample of 3 out of 12 Unit-Level support equipment rules and 2 out of 7 Individual-Level support equipment rules were demonstrated.

c. Cases Presented. The specific cases presented in the demonstration activity are identified in Table L-2. Each case represents a particular set of unit type conditions or equipment support conditions which lead to the selection of the particular rule cited in the table. The rules cited may be inspected in Appendix H (Core Equipment Rules) and Appendix I (Support Equipment Rules).

Table L-2. Cases Used in System Demonstration

Case	Equipment condition present	Rule number
1	Identification of core equipment in FA unit, only ERC-P equipment present	COR-FA-04
2	Identification of core equipment in HQ unit, only ERC-A equipment present	COR-HQ-02
3	Tier 1 equipment used for alignment/registration	T1-01
4	Tier 1 equipment used for control	T1-02
5	Tier 1 equipment used for electrical power	T1-03
6	Tier 1 equipment used for positioning	T1-05
7	Tier 1 equipment used for transport	T1-07
8	Tier 1 equipment used for enhancing operation	T1-11
9	Tier 1 equipment used to exercise equipment	T1-13
10	Tier 2 equipment used for maintenance	T2-08
11	Tier 2 equipment used for shelter	T2-10
12	Unit-level equipment used for NBC defense	UN-01
13	Unit-level equipment used for active defense	UN-05
14	Unit-level equipment used in working environment	UN-09
15	Individual-level equipment used to assess situation	IN-01
16	Individual-level equipment used for mobility	IN-03

L-7. **DEMONSTRATION RESULTS.** A summary of the comments provided informally by the observers follows:

a. **System design**

- No changes were suggested to the basic system design, namely the Equipment Classification Schema or the Equipment Support Relationships described in Chapter 3.
- The need for revisions to statements in some of the rules was pointed out, to either clarify the support conditions being described or include additional support conditions.
- The system terminology problem, which was a source of initial difficulty was felt to be manageable by both training in system use and some simplification of the system nomenclature.

b. **System Operations**

- There has been an initial criticism of the slowness of response of the system. This was corrected by deleting the programing associated with report generation (for an audit trail). The resulting increase in speed was satisfactory.
- The continued need for a report generation capability was affirmed by the observers.

c. **System Status**

- The observers expressed satisfaction with the potential for ERC assignment demonstrated by the system. They endorsed its continued development in a follow-on effort.
- The observers affirmed the need to conduct a formal validation of the system, as part of the follow-on effort, to assure the integrity of the fielded system.

APPENDIX M

MINUTES OF FINAL SAG

INFORMATION PAPER

DAMO-ODR
19 Mar 87

SUBJECT: Minutes of SAG, Expert Systems Initiative in Logistic Readiness (ERC Advisor)

1. The Study Advisory Group (Roster at Encl 1) met at 1000 hours, 26 Feb 87, to receive a final results briefing from the study agency (CAA). Mr. Jim Connelly, of CAA, briefed the group (Roster at Encl 1).

2. The briefing included the study objectives, the study essential elements of analysis, findings, and an outline of a follow-on effort. The group agreed that the goal of the feasibility study was adequately attained and the SAG approved the CAA plan for a follow-on development.

3. Particular attention was addressed to the limited success with the field test of the system at Headquarters, TRADOC due to: Unfamiliarity of TOE coders with this type of system, limited speed per iteration, because of relatively small memory of TRADOC PCs (WYSE-256K), and the need for rule refinement. The TRADOC member acknowledged that the problems were present, but was satisfied, on balance, with system operation.

4. As outlined in the briefing, the next phase will take the prototype to a 95% development point. That is 95% of the ERC assignments made by system, under test conditions, will agree with accepted assignments. During the follow-on development, HQ TRADOC will provide technical support and the TRADOC schools will provide functional area support. Having achieved 95%, HQ TRADOC will become the system manager/maintainer and CAA will withdraw. IOC is expected to be 1st Qtr 1988.

5. The following concerns were expressed by SAG members during the course of the discussions:

a. There is a great deal of personnel turbulence at school and HQ TRADOC combat development shops. Therefore, the fielding plan must include the start-up time to train new people on system parameters.

b. How will Tier 1 and Tier 2 equipment be distinguished? BOIP and expertise will be used to define support relationships.

c. What about dual mission equipment? The ERC Advisor will automatically defer to the higher ERC.

d. We need to insure that the system we build has the built-in

DAMO-ODR
SUBJECT: Minutes of SAG, Expert Systems Initiative in Logistic Readiness (ERC Advisor)

flexibility to accept the data eventually available to break data down from the paragraph level of roll-up to the line item level of detail. That will give the Army the power to differentiate between portions of equipment which have multiple functions within a paragraph.

e. It is clear that formal, scheduled training must be an integral part of system fielding.

f. Standard TRADOC workstations are too small to efficiently use this expert system without reductions which may effect efficiency. TRADOC is exploring options; however, there is no set resolution date.

g. After initial fielding the need will arise for the system to eventually expand to accommodate TDAs. TRADOC is the user for TOE ERC; but, TDAs are built at the MACOMs, making them also future users.

h. The authority to change system rules is an issue that must be formalized. The tentative plan is for day to day resolution to reside at HQ TRADOC, unless the change would result in a violation or change to AR 220-1. Oversight would reside with the sponsor, HQDA, DAMO-ODR.

i. HQ TRADOC's main concern for the next phase of development is that the system is fast enough to increase efficiency, while simultaneously insuring consistency.

6. The SAG adjourned at 1230 hrs, 26 Feb.

Connie A. Brown
CONNIE A. BROWN
LTC, GS
Chief, Systems Branch

ATTENDANCE ROSTER, ERC ADVISOR SAG, 26 FEB 87

NAME	AGENCY	TELEPHONE
LTC CONNIE A. BROWN (Sponser)	DAMO-ODR	697-5730
MAJ Shep Snow	DAMO-FDR	694-0463
MR JAMES CONNELLY	CAA(CSCA-FSL)	295-1645
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MR DON VITTORINI	HQ TRADOC, ATCD-OP	AV 680-2204
MR BILL RANDOLPH	HQ TRADOC, ATCD-OP	AV 680-2204
MR ISAIAH GREENE	DALO-SMD	697-8002
LTC J.R. MCGARRAHAN	DACS-DMA	694-6900

ABSENTEE MEMBERS

MR CHUCK HALL	DALO-PLF	695-9164

APPENDIX N

SPONSOR'S COMMENTS

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, DC 20310 - 04

REPLY TO
ATTENTION OF

DAMO-ODR

9 July 1987

MEMORANDUM FOR: DIRECTOR, US ARMY CONCEPTS ANALYSIS AGENCY, ATTN: CSCA-FSL (5-5d), Bethesda, Maryland 20814-2797

SUBJECT: Export System Initiative in Logistic Readiness Study

1. Per your request, this office has reviewed subject study and has additionally solicited comments from other members of the Study Advisory Group (SAG).

2. The subject study report is a well assembled and supported document that reflects the innovative efforts of the members of your staff who have worked to make the Expert System Initiative look so promising. Mr. Jim Connelly and his supervisor, Mr. Howard Whitehead, have done some excellent work for the Army. The results will show in better force readiness down the road.

3. All members of the SAG concur. Substantive comments are at Enclosure 1.

Encl

WARD A. MILLER
Colonel, GS
Chief, Force Readiness Division

STUDY CRITIQUE

(This document may be modified to add more space for responses to questions.)

1. Are there any editorial comments? Yes If so, please list on a separate page and attach to the critique sheet.

2. Identify any key issues planned for analysis that are not adequately addressed in the report. Indicate the scope of the additional analysis needed. See Encl 1

3. How can the methodology used to conduct the study be improved? See Encl 1

4. What additional information should be included in the study report to more clearly demonstrate the bases for the study findings? Encl 1

5. How can the study findings be better presented to support the needs of both action officers and decisionmakers? Encl 1

6. How can the written material in the report be improved in terms of clarity of presentation, completeness, and style? Encl 1

Encl 2

STUDY CRITIQUE (continued)

7. How can figures and tables in the report be made more clear and helpful? Excell

8. In what way does the report satisfy the expectations that were present when the work was directed? See Cover Letter

In what ways does the report fail to satisfy the expectations? N/A

9. How will the findings in this report be helpful to the organization which directed that the work be done? Full implementation will result in a more consistently uniform ERC coding. Force readiness assessment will be greatly improved.

If they will not be helpful, please explain why not. N/A

10. Judged overall, how do you rate the study? (circle one)

Poor Fair Average Good (Excellent)

DACS-DMA (9 Jun 87)
SUBJECT: Expert System Initiative in Logistic Readiness Study

TO DAMO-ODR FROM DACS-DMA DATE 26 Jun 87 CMT 2

1. Subject report has been reviewed by this office for its application of Artificial Intelligence techniques.

2. The study does an excellent job of providing the proof of concept for the use of expert systems to support complicated information transfer activities.

3. Some revision comments are offered:

a. Table 2-1 on page 2-3 identifies inappropriate prices for the tools called "KEE" and "ART". Their identification as "research and development environment tools" is also inappropriate. These tools are also "application environment tools" like those above them on the list. These two tools would also be better described as "multiple paradigm" mode of operation rather than "Hybrid." Request that the study report authors contact this office to obtain more accurate, comparable pricing data.

b. In Appendix G the authors express concern over compliance with DOD standard 7935-1. Use of that standard is correct, however, as the author states, allowance for the fact that Expert System Technology validation varies from that for "normal" or conventional software. In short, departures of the kind described by the study authors are appropriate for the software used.

c. It would be good to add to the discussion of this project some information as to how these prototype efforts might be integrated into similar, parallel work being conducted by the Logistics Center. In this way it would be possible to show how the work done to date could be transferred onto more capable hardware/software packages that could handle the volume of data necessary for full scale use.

J. R. McGARRAHAN
LTC, GS
Deputy Director, ARtificial Intelligence Center

Encl w/d

Encl 1

DALO-SMD (DAMO-ODR/9 Jan 87)
SUBJECT: Expert System Initiative in Logistic Readiness Study

TO DAMO-ODR FROM DALO-SMD DATE 22 Jun 87 CMT 2
Mr. Ericson/ml/74376

1. Application of the experts systems technology to the assignment of Equipment Readiness Codes (ERC) has the potential of significantly changing the readiness ratings of the Army. Prior to implementation, a complete test of the system is essential, which must include a comprehensive comparison of various type organizations with existing MTOEs to determine the extent and possible negative effect on the total Army readiness posture. Implementation of this system, if approved, may require phasing.

2. Recommend a reasonable degree of success be ascertained prior to official changes to the Army equipment readiness code.

FOR THE DEPUTY CHIEF OF STAFF FOR LOGISTICS:

LESLIE C. CUNNINGHAM
Chief
Equipment and Readiness
Division

Encl 1 as

DAMO-FDR
SUBJECT: Expert System Initiative in Logistic Readiness Study

DAMO-ODR DAMO-FDR 17 JUN 1987 CMT 2
ATTN: LTC Brown

1. Support the concept of applying expert systems technology to determine Equipment Readiness Codes, but it is unclear how this rule-based procedure would compare with an example-based system. Consequently, the need for a phased implementation cannot be addressed nor the extent of additional rules to develop an all-inclusive system. There may be further questions of PC application to accomodate the extensive data file as well as related issues of hardware/software funding and level of fielding appropriate. A proliferation of PC-based systems brings problems with configuration control, etc. Recommend a mainframe (or remote dial-up) application to standardize TRADOC-wide. Otherwise, there is no check to insure that correct rules were used.

2. Secondly, the procedure does not address distribution to TDA units. Since TDA units do not have ERCs their distribution by default is after all ERC A and B requirements have been satisfied Army-wide. However, there may be occasions when it is appropriate to consider TDA units in the prioritization process. Recommend that this aspect be considered in the initiative.

3. DAMO-FDR POC is LTC Smith, X70424.

FOR THE ASSISTANT DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS,
FORCE DEVELOPMENT:

JAMES J. CRAVENS, JR.
Colonel, GS
Chief, Requirements, Programs
and Priorities Division
Force Development Directorate

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ATCD-OP

MEMORANDUM FOR: HQDA (DAMO-ODR, LTC Brown), WASH DC 20310-04

SUBJECT: Expert System Initiative in Logistic Readiness Study

1. Concur with the final draft study report, with the following comments:

a. The follow-on work to achieve the 95 percent development point, as stated in Appendix M, Minutes of the Final SAG, paragraph 4, is understood to include the following responsibilities and support requirements:

(1) HQ TRADOC will assist as necessary to schedule a detailed field validation of the system. This will entail on-site workshops with TOE/BOIP developers from TRADOC schools/centers to expand the system rule base.

(2) HQ TRADOC should determine and provide system management interface with CAA so that TRADOC can gain required expertise to manage the system once it is turned over to Army users, including TRADOC.

(3) CAA will provide an estimated two manyears of analytical effort to provide a usable system to the Army and TRADOC.

b. This study has provided valuable insights into the factors affecting the assignment of Equipment Readiness Codes (ERCs). The Equipment Classification Schema in paragraph 3-5 a is a more clearly expressed rationale for ERC assignment than is found elsewhere. Recommend this approach be considered for incorporation in the next revision of AR 220-1, Unit Status Reporting. This office is prepared to assist in such a revision.

2. Proofreading comments are noted in the attached copy of the draft report on pages 3-6 and 3-9.

3. POC for this action is Mr. Randolph, ATCD-OP, Autovon 680-2204.

4. Reference: DF, DAMO-ODR, subject as above, 9 June 1987.

FOR THE COMMANDER:

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APPENDIX O

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GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

adapt	connect, attach, link, or otherwise allow supported equipment to operate as intended
ADP	automated data processing
advisory system	same as expert system except that the terminology places emphasis on the use of the system rather than its origins.
ADVISOR	abbreviated form of equipment readiness code advisor system
AI	artificial intelligence
AR	Army regulation
ARSTAF	Army Staff
back-up	provide an alternate means of performing function of supported equipment.
BOIP	basis of issue plan
control	direct operation of a support equipment by orders, manual calculations or automatic means.
core equipment	equipment essential to the performance of the unit mission. Same as pacing item, if pacing item(s) identified for unit in AR 220-1.
DAMPL	Department of the Army Master Priority List
DCPC	direct combat probability codes
domain	the nature and extent of the subject matter captured in the knowledge base, that is, the area of expertise of the system.
DPFO	data processing field office
EEA	essential element(s) of analysis
enhance	operate in conjunction with the supported equipment to permit operation with greater flexibility, capability, or efficiency.

ERC	equipment readiness code, a three-level code (A (highest), B, or C) which is assigned to an equipment in a unit, to indicate its importance to the conduct of the unit mission. Within the A-level, especially important equipments are assigned the level of P (pacing).
ERC-P	on equipment assigned an equipment readiness code of "pacing."
exercise	activate the supported equipment so as to simulate realistic operation, for test or training purposes.
expert system	a computer program that uses knowledge and logical inference procedures to solve problems that normally require human expertise for their solution.
goal	final outcome sought by operation of expert system, namely the selection of the ERC for a particular equipment.
HQ	headquarters
inference	the logical process by which an expert system works through a set of rules in its knowledge base to reach a conclusion.
inference engine	computer term designating the program code associated with the inference process in an expert system. See inference.
individual-level support equipment	support equipment used personally by individuals to assist them with the performance of their duties.
initialize	equipment used to align, calibrate, adjust supported equipment prior to operational activity.
KEE™	Knowledge Engineering Environment™
knowledge base	specific collection of knowledge (facts and heuristics) structured as a set of rules within an expert system.
LIN	line item number
LISP	list processing (programing language)
maintain	used to service supported assets.
microcomputer	desk-top computer for individual use.
mission	the basic operation(s) the unit is designed to perform.

mission-task	the restatement of the unit mission into one or more components (mission tasks) each of which has its own core equipments.
MOS	military occupational specialty
NULL	name assigned to rule in ERC ADVISOR system which indicates an ERC assignment can not be made.
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
pacing equipment	an item of equipment essential to conduct the mission of the unit as identified in AR 220-1.
position	move supported equipment to locale of operation, and remain in place awaiting next move of equipment.
power	provide electrical power for sustained operational use of the supported equipment.
protect	house or cover supported equipment against threatening environmental/hostile conditions.
support	equipments which enable or facilitate the operation of the principal equipment in a unit.
supply	move, hold, or issue supplies to supported equipment.
sustain	provide flow of ammunition or supplies necessary for sustained operation of supported equipment.
TAEDP	Total Army Equipment Distribution Program
Tier 1 equipment	an equipment which directly supports the operation of a core equipment.
Tier 2 equipment	an equipment which directly supports the operation of a Tier 1 equipment and thus indirectly the operation of a core equipment.
TOE	table(s) of organization and equipment
TRADOC	US Army Training and Doctrine Command
transport	move supported equipment to a locale of operation, and then become available to move other equipment.
unit-level support equipment	equipment used to support unit operations and unit facilities.

validation	process of evaluation of the performance of an expert system.
working memory	memory allocated by expert system to hold results of ongoing processing of rules.
workstation	desk-top computer for individual use in either a standalone mode or for access to another system.